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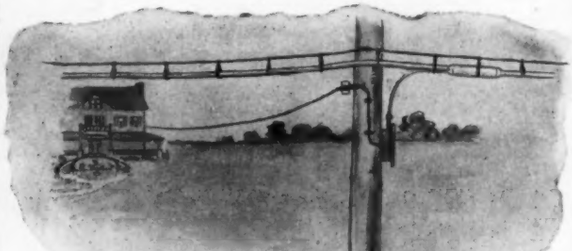

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TELEPHONE ENGINEER

Edited by Paul H. Woodruff

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VOL. XXIII *Chicago, February, 1920.* *No. 2*

The Same Old Rate Question

THOUGH all telephone men are interested in rates, because they are dependent upon them, not all are in direct contact with the rate-making problem. So there are many of them who, viewing the pleasing procession of increases allowed by state commissions, are inclined to think, "Well, the old rate question is settled at last."

But the fact is, an increase is not always an increase. Primary-school arithmetic says that when rates are five per cent too low, and expenses go up thirty per cent, and then rates are raised thirty per cent, the rates are still five per cent too low. Simple as that problem is, its significance has escaped many people. Operating managers are just as human as are those of their employees who, receiving twice their former wages, think they are twice as rich as before, in spite of the dollar's fifty-per cent shrinkage.

In a great many cases, rate increases recently granted meet fairly well the increased cost of doing business, without helping in the slightest degree to remove the old deficit. Furthermore, the relief so graciously granted by the commission puts the companies in a somewhat embarrassing position as to requests for immediate further increase.

The answer, of course, is that new rates should have no particular relation to old rates. There is too much tendency to ask for, or talk about, increases of so much per cent. We repeat that there is only one correct rate for each situation, regardless of the present schedule. A truly scientific method of rate finding would not even take the old rate into consideration, since it may be no guide at all.

All the problems of construction and labor wages that are going to be discussed at the Atlanta convention merge more or less directly into this question of still higher rates; for the telephone companies cannot reduce either commodity prices or wage schedules, but must meet them. So the whole discussion might as well center on that point.

The City Shows Its Hand

WHATEVER conditions were before state commissions were invented, it is plain enough now that city control would be the worst misfortune that could befall a public utility. Efficient utility management demands and expects a square deal, and nothing more. Municipal regulation, in nine cases out of ten, does not give that. To the municipal politician, a "deal" means something very different.

An occurrence a few days ago in Chicago illustrates the point very nicely. For some years the city has been conducting a public service commission of its own. Now the "telephone supervisor" of the bureau, a well-known and thoroughly competent engineer, has been suspended by the commissioner, and is to be charged with "inefficiency." In extenuation of this action, the commissioner naively presents an explanation that indicates the supervisor's real fault to have been efficiency and honesty. And the explanation, in addition, throws light on the municipal attitude.

The direct charge against the Chicago supervisor is that he had been "too friendly with the telephone company." Observe, now, the evidence: Five years before he had presented a report in which it was shown, as a fact, that the operating company's bills for measured service, instead of being higher than they should be, were sometimes actually lower. Lately, on the witness stand, he identified that report.

It is not quite clear whether the municipal authorities expected the supervisor to repudiate and deny his own report in court, or felt that he should have concealed the fact that the company's billing was honorable. Either action might have harmonized well with the municipal code of ethics. We are glad to say that neither would accord with the principles of a telephone engineer.

It is the municipal idea of utility control to discredit the utility by fair means or foul. The ideal municipal employee is the one who is willing to twist his reports and his figures to that purpose. Any facts that prove the utility to be honest are to be suppressed, and any employee who recognizes any good in the utility is to be suspected. This is the kind of mental process that makes it possible to call an engineer inefficient because he is efficient, and to turn his accuracy, honesty and engineering respect for facts into a reflection upon him.

State regulation may have some faults, but it is the only safe and sane regulation so far invented. And the thing above all that makes it safe and sane is that it accepts the findings of its engineers, whether they are for the utility or against it.

The Telephone and Stand Seen in Use in the Left View and in Repose at the Right, Was Invented by Miss Katharine Nichols of the Cooper-Carlton Hotel, New York. Those Who Have Used It Claim That It Effectually Excludes Outside Noises, and Adds Fifty Per Cent to the Hearing Efficiency. It Has the Added Advantage That the User Is Forced to Keep His Lips Close to the Transmitter.

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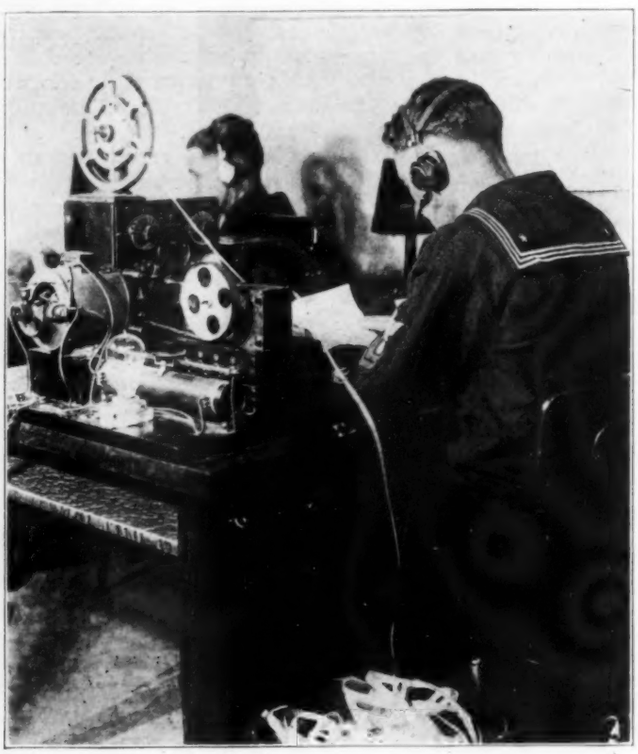
This Wireless Telephone Set and Brunswick Phonograph Transmitted a Musical Program from Chicago to Fort Sheridan the Other Day for the Benefit of Soldiers in the Hospital, and the Music Was Overheard by Wireless Operators as Far Away as Detroit. Damped Waves of 700 Meters Were Used Enabling Any Amateur to Get in on the Entertainment. The Range of This New Radio Telephone is Close to 400 Miles.



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Transatlantic Radio Room in the Navy Department, Equipped With Multiplex Radio Outfit, for Keeping in Touch With Several Ships at the Time. The Transmitter Takes the Perforated Tape at 200 Words a Minute. Five Vertical Pins Fit Into the Perforations, the Multiplex Code Consisting of Various Combinations of Dots in Vertical Positions, Each Dot a Letter.

Squier Multiplex System is Ready

First Line to be Installed Between New York and Albany Very Soon

THE first commercial installation of a multiplex system of telephony on the plan originated by Major-General George Owen Squier, chief United States signal officer, will in a short time be in actual operation between New York City and Albany. Old-time readers of TELEPHONE ENGINEER will recall the description of this remarkable system, published in February, 1911—exactly nine years ago. Considerable comment was aroused at that time by the inventor's action in releasing his patents, Nos. 980,356, 980,357, 980,358 and 980,359, for public use. Development of the system progressed until interrupted by the war, and after the armistice was resumed with such vigor that it is now ready for use.

With the Squier system at least ten, and possibly more, conversations, may be held at the same time over a single line. The method, it is said, makes long distance transmission practically limitless. Conversations from Nome to Rio, and from Argentine to Alaska will be a matter of course, provided single wires are strung between those points. It will save telephone companies large sums of money, as by its use one wire will do the work now requiring several.

Successful tests of the method have been made by government experts recently along the line of the Harlem division of the New York Central Railroad. The results have been so gratifying that General Squier will soon make a formal announcement. A government car was established at Millerton, N. Y., under the direction of Lieutenant R. D. Duncan.

Squier's "wired wireless" is really a system of guiding radio waves or currents by means of a wire. The impulses travel through the air alongside the wire, which guides them to their destination. The method eliminates one fault of the radio in its ordinary form, which sends its messages broadcast in every direction. Under the Squier method the wave currents stay close to and follow the wires, insuring reliability and secrecy.

The principal difficulty in ultra-long distance telephony has been that to carry the direct current to a great distance requires conductors so large as to be uneconomical and almost impracticable. The new method has adapted an alternating current of high

Major General George O. Squier, Chief U. S. Signal Office. He Was Major Squier When This Photo Was Taken.

frequency to the use of the telephone through adaptation of the instruments used in wireless telegraphy to that purpose.

The high-frequency current travels along the wire, but not in it, passing through the ether as do radio waves, with the difference that instead of being diffused it travels in a path of which the wires serves as a core. Some persons who have followed General Squier's work believe that ultimately as many as fifty messages may be sent along one wire simultaneously.

The congestion of telephone and telegraph service during the war gave an impulse to further experimentation with the new method, with the result that those interested in the work believe they have found a day to eliminate wire congestion for good and all. On the ordinary telephone wire the frequency of the alternations run from 750 to 2,500 cycles a second. The Squier method increases the frequency and rapidity of the vibrations so that they may reach as high as 500,000 cycles a second.

In addition to its other uses, it is said that the new method will enable conversation to be carried on between moving trains and fixed points. The method entails no additional expense to telephone and telegraph companies, it is reported, except the cost of the special generating equipment for the high-frequency current at each end of the line.

The inventor believes that the new system may possibly do much to remove causes of international friction. Communication would be made so inexpensive that widely separated peoples no longer would regard their long-distance neighbors as potential enemies. Talk between South America and the United States along the line of wires already existing between the continents would readily be made practicable. All that would be needed would be the alternating-current generator, and transmitters and receivers. The cost of generating the current would be insignificant.

General Squier is a pioneer in wireless work. He was associated with Marconi at one time, and has many inventions to his credit, all of which have been turned over either to the government or to the public. He is a West Point graduate, and has taken scientific courses at Johns Hopkins University.

Experts to Settle Europe's Telephone Troubles

An immediate meeting of experts from all countries with a view of ameliorating the situation relative to posts, telegraphs and telephones, was decided upon by the Supreme Economic Council.

The French delegate asked that the council co-operate closely with the League of Nations, but decision on this point was deferred. In the meantime the council will investigate the economic situation in Europe and will maintain contact with the economic section of the League of Nations.

Independent Convention in Atlanta February 4 to 6

UNITED STATES INDEPENDENT TELEPHONE ASSOCIATION.

Convention Headquarters, Room 918 Piedmont Hotel.
Information, Room 918.
Georgia Independent Telephone Association Headquarters, Room 908.
Registration, Room 918.

PROGRAM

FEBRUARY FOURTH—WEDNESDAY MORNING.

10 A. M.—Convention Hall—Ninth Floor—All exhibits closed during program.
Invocation—Dr. Richard Orme Flinn, Atlanta, Pastor Presbyterian Church.
Address of Welcome—Honorable Hugh M. Dorsey, Atlanta, Governor of Georgia.—Response.
Address—F. B. MacKinnon, Washington, D. C., President United States Independent Telephone Association.
Discussion: Regulation—Honorable Murphy Candler, Atlanta, Chairman Georgia Railroad Commission, former Vice-President National Association of Railroad and Utility Commissoners.
Discussion: Question Box—In charge of B. Y. Chambers, Moultrie, Ga., Assistant General Manager Consolidated Telephone & Telegraph Co.
General Business Session—Appointment of Convention Committees—Miscellaneous Business—Announcements—Adjournment.
Visit exhibits.

FEBRUARY FIFTH—THURSDAY MORNING

10 A. M.—Registration, Room 918—All exhibits closed during program.
Public Relations—J. Prince Webster, Atlanta, public service expert and attorney, former rate expert of Georgia Railroad Commission.
Discussion: Close-Up Publicity—W. S. Vivian, Chicago, secretary-treasurer United States Independent Telephone Association.
Discussion: Rate Reduction During the Past Few Years.
Discussion: Question Box—In charge of B. Y. Chambers, Moultrie, Assistant General Manager Consolidated Telephone & Telegraph Co.
General Business Session—Reports of Committees—Miscellaneous Business—Announcements—Adjournment.
Visit exhibits.

THURSDAY AFTERNOON.

Annual meeting of the Georgia Independent Telephone Association.

FEBRUARY SIXTH—FRIDAY MORNING.

10 A. M.—Registration, Room 918—All exhibits closed during program.
Telephone Accounting—Charles J. Metz, Atlanta, president, Audit Co. of the South.
Discussion: Wages of Capital—R. E. Pattison Kline, Chicago.
Discussion: Wages of Labor—W. G. Brorein, Tampa, president, Peninsular Telephone Co., director United States Independent Telephone Association.
Discussion: Question Box—In charge of B. Y. Chambers, Moultrie, Assistant General Manager Consolidated Telephone & Telegraph Co.
General Business Session—Reports of Committees—Miscellaneous Business—Announcements—Adjournment.
Visit exhibits.

LIST OF EXHIBITORS FOR 1920.

Exhibitor.	*Room No.*
Automatic Electric Co.	912-913
Barrett Co.	934
Chance Manufacturing Co.	921
Coffey System & Audit Co.	904
Cook Electric Co.	910-911
Delco Lighting Co.	931
Dixie Electric Equipment Co.	936
Edwards & Johnston Co.	904
Electrical Instrument Repair Co.	937
Electric Storage Battery Co.	933
French Battery & Carbon Co.	935
Kellogg Switchboard & Supply Co.	906-907
Leich Electric Co.	916-917
North Electric Mfg. Co.	926
National Carbon Co.	927
Reliable Electric Co.	908-909
Southern Electrical Supply Co.	914-915
Templeton, Kenly & Co.	932
Thompson Levering Co.	930

Telegraph and Telephones in Morocco

There are 2,777 miles of telegraph lines in French Morocco, of which 1,313 miles are available for the transmission of commercial messages.

Over the telephone system of the Protectorate passed 1,372,673 communications in 1917. Telephone exchanges are in operation in the towns of Casablanca, Rabat, Fez, Mequinez, Marrakesh, Fedala, Kenitra, and Sallee. Interurban lines between these towns constitute a complete telephone system in western Morocco.

Conservation of Telephone Poles

Timber suitable for telegraph and telephone poles is becoming scarce and expensive. It is estimated by the Forest Service that sixty years hence will witness the practical extinction of such material.

At present about 4,000,000 poles are being erected annually. Records compiled by the Forest Service show that 95 per cent of all poles are destroyed by decay, 4 per cent by insects and the remaining 1 per cent by mechanical abrasion.

Scientists who have been giving the subject attention advise, as a result of experiments conducted by them, that creosote treatment applied to the ends of the poles and posts imbedded in the ground will lengthen the life of the poles as per the following:

White Cedar—16 years (untreated) to 30 years (treated).

Cypress—6 years (untreated) to 15 years (treated).

Chestnut—12 years (untreated) to 16 years (treated).

Pine—6½ years (untreated) to 20 years (treated).

Juniper—8 years (untreated) to 18 years (treated).

There are three methods of treatment adaptable to the purpose: The open tank method, whereby only the butts of the poles are treated; the pressure process, used only on short poles, and the brush method, which may be applied in the field as the poles are being set. The employment of the open tank method calls for the application of the treatment before the poles are shipped on the job.

As creosote and the labor required to apply it are much cheaper than new timber, it is needless to say that railroad companies, telegraph and telephone companies, farmers and all others using large quantities of timber for poles and posts are giving this matter much serious consideration.

Diaphragms and Sound Measurement

*The Importance of Experimental Study of the Modes of Vibration**

By V. KARAPETOFF

A DIAPHRAGM is the most essential part of an electric horn; it is also an important organ in the telephone receiver and transmitter; it enters in the construction of the phonograph and other sound reproducing devices; it can be used for sound measurements, and it is also the sound receiving part of the human ear. For these reasons, numerous investigations, experimental and theoretical, have been made on all kinds of diaphragms and membranes. As early as the eighteenth century, Chladni experimented with diaphragms of various shapes by putting a little sand on them and setting them into vibration by a violin bow. The sand is immediately driven away from the parts which are violently vibrating to places which are comparatively quiet. The resulting sand figures clearly indicate the shape of the segments into which the diaphragm is divided. The sand diaphragm can be made to vibrate in a number of different modes by suitably holding it with the fingers, and bowing at different places. An account of Chladni figures may be found in almost any standard text-book on sound.

A large number of investigators have worked experimentally on the study of vibrations of telephone diaphragms. In many of these researches a very small mirror was attached to the diaphragm, which mirror reflected light from a powerful source upon a scale on which the vibrations could be read directly.

Some investigators have obtained direct photographic records of vibrations, and a few attempts have been made to reflect light directly from a highly polished diaphragm. Observations have also been taken through a microscope of a stylus attached to the diaphragm.

Future improvements in signal horns and in telephone apparatus will largely depend upon our better knowledge of the modes of vibrations of diaphragms. In an acoustic signal we try to vibrate the diaphragm at one of its natural frequencies, so as to get as nearly as possible a pure tone, with a minimum of excitation. In a telephone receiver or transmitter, or in any other speech-reproducing device, the natural frequencies of the diaphragm constitute a disturbing factor, which gives it a selective sensitiveness for certain frequencies only.

The problem is further complicated by the fact that the diaphragm is seldom used alone, but usually has a horn (projector or mouthpiece) associated with it. This horn adds its natural frequencies due to the enclosed air and thus modifies the properties of the diaphragm itself. Besides, there are unavoidable little cavities where the diaphragm is built into a housing, and these cavities act as resonance chambers, adding to the troublesome selective sensitiveness of the combination.

Copyright International Film Service.
DR. DAYTON C. MILLER, of Cleveland, Ohio, and his invention, the "Phonodeik", a machine which records and later projects upon a screen for study and demonstration, sound waves of all kinds, timbers and qualities. In the background is shown a copy of a demonstration chart, showing how the sound waves appear when projected by the "Phonodeik".

MEASUREMENT OF SOUND INTENSITY.

If acoustics is to become a branch of applied science or engineering, the physical quantities involved particularly the sound intensity, will have to be measured in some simple units and by means of a simple and robust instrument. A steam engine is guaranteed to develop so many horse power at a certain speed; an electric lamp is sold to give so many candle power in a certain direction. So in time an electric horn may be guaranteed to produce a sound intensity of so many "carusos" per square centimeter, at a distance of say one hundred meters from its diaphragm. At least the trend of the development in other branches of engineering has been from inaccurate and confusing Sound waves represent a certain mechanical energy, and therefore their notation by trade-names and by arbitrary numbers, to accurate specifications based upon physical units. intensity should be measured in energy units per square centimeter of area perpendicular to the direction of propagation. Of course, the question of selective sensitiveness of the human ear must also be considered, and the energy measured only within the audible range; the range of maximum sensitiveness of audibility lies between 700 and 3,000 vibrations per second. Thus, when the candle-power of a search-light is specified or measured, only the rays within the visual range are considered, and no credit is given the maker for ultra-violet or infra-red rays.

Just as with the progress of electric lighting of large spaces the need arose for simple portable photometers to measure the intensity and distribu-

*Adopted from a paper read before the A. S. E. E.

tion of illumination, so in time we shall need simple practical devices for measuring sound intensity, produced by an acoustic signal, and its distribution in space. Such need has already been felt in connection with fog signals in which the volume of sound possible with one siren is limited as compared to the wide areas over which it must be heard under adverse conditions of wind.

A simple indicator of sound intensity is the so-called Rayleigh disk which is a small and light vertical disk suspended freely on a fine quartz fiber and placed at an angle of about 45 degrees to the direction of the sound. When sound waves impinge upon it, it has a tendency to place itself at right angles to the direction of their propagation. The sound intensity of the waves may be computed from the observed angle of torsion. In spite of this apparent simplicity this method has not been used much in practical acoustical measurements.

An instrument of considerable accuracy and sensitiveness for measuring sound intensity at a point is the *phonometer*, developed by Dr. A. G. Webster of Clark University. It consists of a hollow cylindrical chamber (an adjustable Helmholtz resonator), one end of which is in communication with the atmosphere, and the other end is covered by a mica piston held in place by three stretched strings at 120 degrees to each other. The resonator is tuned to the pitch of the incoming sound, so that the impinging waves set the mica piston into vibration. The amplitude of vibrations is measured by means of a tiny mirror and a telescope on a scale. The vibrating system which consists of the three strings with a central block and the mica piston must also be tuned to the frequency of the incoming sound.

Some satisfactory measurements of sound intensity have been also made with a sensitive telephone receiver mounted on an intensifying resonator in front of it. Within certain limits the alternating current induced in the telephone receiver windings by the vibrations of its diaphragm, is proportional to the sound intensity, or at least a calibration curve may be obtained between known sound intensities and corresponding currents. The induced currents are exceedingly small and can be measured by the following two methods:

a. Using a crystal rectifier and a d-c. galvanometer of high sensitiveness.

b. By means of a very sensitive vacuum thermocouple.

All these methods are reliable only with pure sounds of a single pitch, and the devices must be tuned to that pitch. Prof. Miller's *phonodeik*, which is a diaphragm device, responds to a considerable range of frequencies, and gives a photographic record of a complex sound wave. Unfortunately it distorts the relative magnitudes of the harmonics because of the resonant frequencies of the diaphragm itself; somewhat tedius corrections are necessary in order to reconstruct the actual sound wave.

It will be seen from the foregoing, that the difficulties in measuring sound intensity are greater at the present time than those attending the measurement of the intensity of light from ordinary illuminants. It is to be hoped that the coming need for practical measurements of sound intensity will lead to a speedy development of a convenient measuring device, even though of moderate accuracy.

EXPERIMENTAL STUDY OF THE PROPAGATION OF SOUND WAVES.

A field of many possibilities in practical experimental acoustics has been opened, due to the development of a method for directly photographing sound waves. This method has been brought to a considerable degree of perfection by Prof. A. L. Foley of Indiana University. In this method, use is made of the fact that a sound wave consists of consecutive condensations and rare-factions of the air, so that the density of the air in the wave front is different from that just ahead and just behind it. Therefor, if a moving sound wave be instantly illuminated with an electric spark, light will be refracted at the places corresponding to the wave front, and an image could be obtained on a photographic plate. Foley used an electric spark as a source of sound, and another spark for illuminating the wave front of the sound produced by the first spark. The two sparks must be accurately timed, in order to catch the wave front in a desired position. Dr. Foley has demonstrated in this manner a concentric wave from a point source, its reflection from a plane surface, and from a convex mirror; refraction of sound waves by acoustic lenses filled with different gases, the action of a diffraction grating, and some other fundamental phenomena in the propagation of sound waves.

Minnesota Unification Progressing Rapidly

Complete unification of local telephone service has been attained in thirty-four Minnesota cities and towns through the peace treaty between the Northwestern Telephone Exchange Company and the Tri-State Telephone and Telegraph Company, which was sanctioned by the Minnesota Railroad and Warehouse Commission. It is estimated by James W. Howatt, supervisor of telephones, that more than 2,000 duplicate telephones already have been eliminated in these thirty-four cities, thereby saving thousands of dollars annually to the patrons. The work of consolidating the service in the three larger cities of St. Paul, Minneapolis and Duluth, is being carried on with diligence, according to the reports from the companies, and when it is completed about 20,000 more telephones will become superfluous.

The communities which formerly suffered from the evils of competitive telephone systems, but which now are enjoying the benefits of a single service are as follows: Albert Lea, Appleton, Austin, Barnum, Bird Island, Bloomington, Braham, Brainerd, Cambridge, Carlton, Cloquet, Crookston, East Grand Forks, Excelsior, Faribault, Foley, Glenville, Graceville, Granite Falls, Hinckley, Isanti, Litchfield, Marshall, Milaca, Moose Lake, Morris, Olivia, Ortonville, Pine City, St. Cloud, Thief River Falls, White Bear, Willmar, and Windom.

There are 2,058 telephone utilities operating in Minnesota at the present time. The great majority are mutual farmer lines, serving only a few patrons. The smallest of all is the Ehlers and Heinen Telephone Company in Lyon County, which has only 2¼ miles of wire and but two subscribers.

Chicago Automatic Work Starts in September

The changing of telephones to a machine or automatic system in Chicago will be started at the Central and Majestic exchanges in September, B. E. Sunny, president of the Chicago Telephone Company, announced. The new system is expected to be in operation on these exchanges early in 1922.

The Advantages of Organization

Address Before a Recent Meeting of Managers of the New England Telephone Company

By L. N. Whitney

GOVERNMENTAL management is management by all the people; it is the largest and most complicated organization possibly conceivable, and obviously involves politics and thousands of other factors, that naturally arouse confusion and suspicion and allow waste and mis-management to develop—what's every one's business is no one's business. There are, therefore, sound reasons why governmental or other similarly large units of management must necessarily operate under serious handicaps, why real team work cannot exist.

If a man does everything for himself, he sees the whole picture of his work, he *knows* that the harder and better he works the more he will have and the happier he will be; and, conversely, the happier he is, the harder and better he works and with less effort. If he trades his products with another, he also sees all that goes on in connection with his work, he is still the complete coordinated unit, and he knows that energy and efficiency will be properly rewarded. The entire route from the receipt to the disbursement of the rewards of production is clear; he sees and understands all.

DANGER IN TOO LARGE UNITS

If, however, he works as part of an organization, association, government, etc., involving many individuals there is necessarily the tendency to obscure the relation between the workers themselves, and between worker and consumer; because the coordinated unit becomes larger and more complicated. The larger the unit of organization, the greater this danger; and there is a point where, in spite of all effort, a comprehensive picture of the processes of the organization cannot be maintained by the workers, to the extent necessary to avoid a degree of suspicion or even antagonism, that means at least a depreciated morale, and generally results in serious embarrassments and failure, through waste and inefficiency. Again, if the units of organization are too large, the cost of extravagant, inefficient, or poor management is not only lost in the enormous expense of the large units, but it is also far from the *source that pays* for such management that the supervisory forces, that are the cause of it, cannot feel the penalties that

L. N. Whitney.

should follow; and consequently lose their incentive to prevent it. For these reasons the natural and unavoidable result of too large units is the lack of that personal, definite recognition of individual work which is so necessary for success.

An approach to the complete coordination and picture of the processes of an organization, on the part of the individuals involved, is essential to success; and the method of visualizing the entire picture must be simple, so that the average individual not trained to do such visualizing may easily do so. This can only be obtained when the units of organization are complete and small enough and the spirit is broad enough, to permit of obvious, personal, pecuniary incentives, on the part of the individual people involved in the enterprise, for the success of the undertaking. Under such conditions anything that even tends to oppose maximum production must necessarily oppose the best interests of every individual connected with the undertaking. Any extravagance, inefficiency, etc., is quickly allocated by the employes, the owners, and the patrons; all are immediately active—the employes on the basis that the best man is not winning—the owners and the patrons on the basis that the return is low or the rates are high. The entire route from receipt to disbursement of revenues is comparatively short; is direct enough to be clear to all involved; and, once established, the value of such a route is quickly recognized and maintained accordingly. This is really a simple and direct form of that much discussed panacea of profit sharing; for the individual has a direct interest in the results derived from the particular unit with which he or she is associated.

DEVELOPMENT OF INDIVIDUAL INTELLIGENCE.

There is serious doubt as to whether many commercial enterprises are not failing to maintain these desirable conditions, largely for the reason that the technical developments too far outsrtip the development of the individual in comprehending the enterprise as a whole. That is, the business machine is too large or too specialized, or both, to be understood by the great body of employes. It is not the tendency to develop that is undesirable; but we must be sure to so arrange such development that it will carry along with it, the development of an individual intelligence. There must be a coordination of comparatively small units that will visualize the industry as a whole, to an extent that will avoid that suspicion that is often extensive enough to develop into real antagonism. We must recognize the necessity of knowing not only the technique of material equipment and methods, but also the technique of human nature—the problem of how individuals should work together.

Personal direction and instruction for each employe, as an individual unit, is impossible by the head of large modern business undertakings—departments, divisions, subdivisions, etc., are necessary; but these should be set up so as to lead toward and not away from a visualization of the undertaking as a whole. Central control is necessary, but the different functions must come together often, and from a unit that will provide a clear, complete picture of the whole; so as to create interest, avoid the demoralization that results from the monotony of too great specialization, and in order that all may better grasp the requirements of the business as a

whole; and then have an opportunity to devise improved methods of meeting such requirements.

SUPERVISORY FORCES SHOULD ENCOURAGE INQUIRY

With such properly arranged units the opportunity to devise improved methods is best developed by having the supervisory forces honestly and enthusiastically solicit from the employes active and sincere thought and decision, concerning not only their personal problems but also problems in general that relate to the enterprise with which they are associated; on the basis that proper solutions positively result in personal benefits to the individual employe. The supervisory forces should encourage the inquiry on the part of each individual, as to *why* each unit of work is performed at all, and then why it is performed in the *way* that it is. In this way we secure a personal, powerful, *en masse* motive for *improved* methods of conducting our business; and such motives will also necessarily develop a skillful and faithful execution of *existing* methods. All work becomes conducted on the soundest possible basis, i. e., the irresistible force of mutual self-interest, for success and economy in the administration of the enterprise and for promptly killing whatever prevents or even impedes it.

Sometimes the supervisory forces of an organization hesitate to do this, on the theory that it reflects on their ability; but they should realize that they have a greater burden and greater responsibility than human beings can possibly carry *alone*; and that the simplest and most effective help will come from the forces supervised, just as soon as these forces are given a proper opportunity to appreciate the processes of the organization as a whole, and know that they will be properly rewarded for suggested improvements. With this will also come the demand for the very best managerial ability on the part of the supervisory forces; and good managerial ability always carries with it the most thorough and satisfactory subordination to proper authority. Both of these factors are obviously essential to real success. Furthermore, when the individual understands the different processes of an undertaking there is the frequent opportunity of helping, or even trying, the other fellow's work; the monotony of continued highly specialized work is largely avoided; the individual soon realizes the work for which he or she is best suited; and there is natural, gradual gravitation toward the work which will provide for the greatest contentment and resulting efficiency.

There are, however, many instances where this social progress of business lags behind the technical developments, because the latter have felt they could advance without the former—it is no more possible than that the most wonderful machine can operate without power. Moral law is as essential as economic law, in any sound business. Much of this trouble is due to the officious egotistical principles that have prevailed in the past. An egotist generally opposes every one but himself; this naturally first develops hurt feelings, then lethargy, and this is followed by determined demands for changes—a situation that exists in many places today. While the egotist has no chance to win, history teaches that the longer and harder he fights against his associates and the ultimate result, the greater the damage and the greater the unrest. Therefore, let's be sure we promptly eliminate all egotism; and also be sure that we do *not* do it on the basis of philanthropy, or on the basis of charity for the feelings of others, for it is far from that, and will not be accepted at all if presented on such a basis; it must be purely upon the principle that there is no right without obligation—the right to supervise carries with it the obligation to co-operate.

INCREASED PRODUCTION IS SOLUTION

I believe that we will agree that our great present-day problem is that of increased production; that the present tendency of increased consumption and decreased production must be reversed; that no other choice is open. It is hard to do this when the atmosphere is continually charged with disturbing and distracting influences, that are destructive of the calm and poise essential to contentment and its resulting advantages. But I believe that the earnest, natural, individual attitudes that have helped us so much in the past are practically those that I have been describing; and that their continuance will further develop our desire to produce, to originate new ideas, to reduce the labor required per unit of output, to really achieve results and enjoy seeing our ideas succeed; this because our set-up is such that the results of such efforts are so supervised, that they are closely associated with our advancement and consequent contentment. Instead of blindly providing a predetermined reward for the individual, and then trying to insist that it be properly earned, we provide an unlimited opportunity for all, and then insist that the individual results obtained be properly rewarded, in accordance with the capacity of the business. This is a simple, sound, human spirit, the development of which means that plain, old-fashioned co-operation and efficiency that has always given good productivity; and which in turn has always assured success.

When we stop to think over these fundamental facts of organization and management, that I have mentioned, we see that we have, on one extreme, governmental organization with the routes of relationship among the individuals complicated beyond comprehension; while on the other extreme we have the *individual*, where the route of relationship is *nil*; between the two, lies the solution of successful modern production. Our small commercial units are just about far enough from each of these extremes, to provide for the greatest possible specialization without losing that necessary comprehensive picture and interest in our processes as a whole, of which we have been speaking. We have, therefore, been able to do a good job along all these very important lines; and our practices developed by those who use them, are constantly improving.

"WHYS AND WHEREFORES"

I am convinced, however, that our progress so far has been, and our future progress will continue to be, in direct proportion to the sincerity of interest and breadth of conception that we give to these fundamentals. I wish, therefore, that each manager would make up his mind that, through our small units of organization, he will become even better acquainted with our associates and processes; become even better acquainted with individual abilities and ambitions; and resolve to give everyone the widest opportunity to inquire into, and become interested in, the "whys and wherefores" of our department. Then let's try to have every position in the department open to every member, based on ability, accomplishment, experience, and opportunity; be sure that any one who, through conscientious, earnest efforts, develops improved methods, or in *any* way earns rewards greater than the average, shall have them. In this way, we as individuals are bound to develop; and

(*Continued on Page* 41)

Characteristics of Automatic Equipment

Abstracted from "Applicability of Automatic Switching to All Classes of Telephone Service"*

By ARTHUR B. SMITH*

AUTOMATIC apparatus of various kinds has been described so often that a general explanation is unnecessary. The type best known has been the subject of papers, as well as of a few books.

Factor of safety is a thing of great importance. Upon it depends the maintenance expense and the dependability of the service rendered to the public. This is the principle which guided the development of automatic switching. Seemingly small details exert great influence upon the performance of apparatus. Some factors do not impress the casual observer, yet they have great influence upon results.

A brief presentation of some of the improvements which have been made in recent years will bring the record of the subject up to date. It concerns chiefly the redesign of parts of the apparatus and the standardization of the assembly, adjustment, and mode of maintenance.

The automatic switch, Fig. 1, presents a new general appearance. The relays are mounted above, the magnet mechanism in the middle, and the banks and wipers below. The relays and magnets are protected by a cover individual to each switch.

The material of the switch frame have been changed from die-cast metal to cast iron, heavily zinc plated. The die-cast frame was subject to warping. It necessitated rather frequent readjustment of the mechanisms mounted on it and sometimes even the chipping down of a lug which interfered with the movement of the wiper-shaft. The cast iron frame is rigid and unchanging. Apparatus mounted on it requires no attention from this cause.

The sideswitch has been abolished on nearly all switches and its work performed by relays. The sideswitch as made was the source of considerable trouble due chiefly to the wiper friction. Its elimination has greatly increased the certainty of action of the switch as a whole.

The relay has been completely redesigned (Fig. 2). The pin-pivot has replaced the point-pivot, the insulation between contact springs made permanent, and each relay rendered mechanically independent of all other relays.

The point-pivot, when adjusted without play or bind was as fine a pivot as could be made. But it was desired to have a pivot which would need no adjusting at all. The plain pin pivot has just enough play to make the armature work freely, and the wear is inappreciable. The point

*Read before the American Institute of Electrical Engineers, New York, December 12.

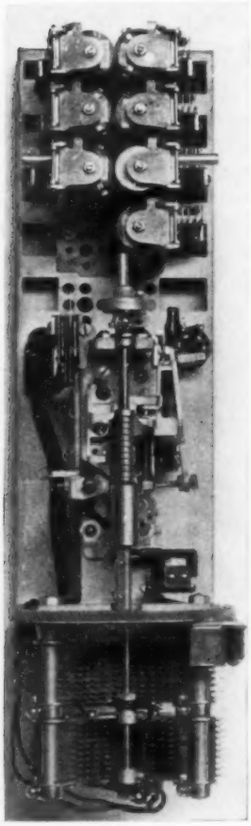


Fig. 1a—Connector Switch (Front View)

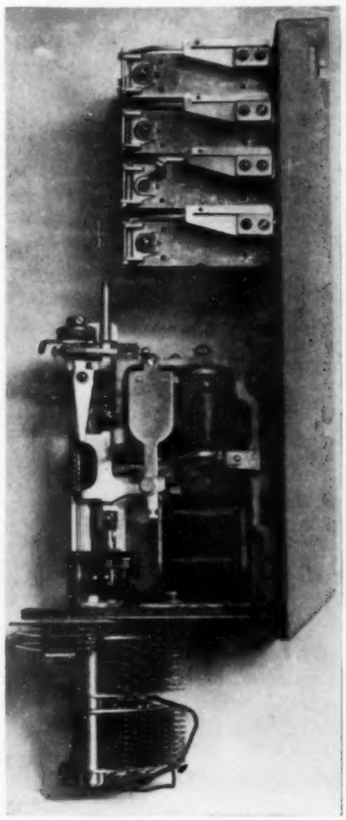


Fig. 1b—Connector Switch (Right View)

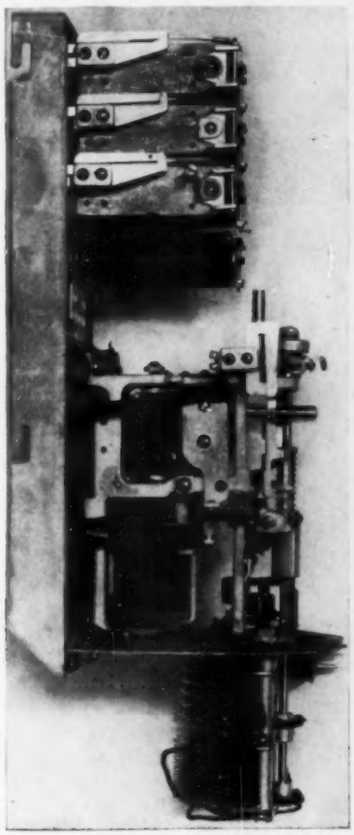


Fig. 1c—Connector Switch (Left View)

Fig. 1d—Connector Switch (Rear View Uncovered)

pivot is retained on the line relay of the plunger line switch, where the conditions are not severe.

The relay contact springs are insulated by phenol-fibre, which is a good insulator and very constant. Each assembly of springs is aged by heat treatment, so that it is practically one solid mass. Looseness and uncertainty of spring action have been practically wiped out.

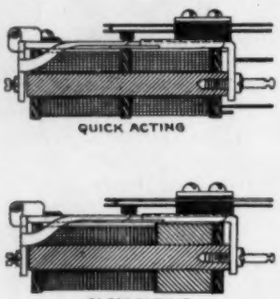


Fig. 2—Horizontal Automatic Relays

The relays are mounted individually on a base plate, Fig. 3. This base plate has openings through which the relay terminals (for coils and springs) extend to the rear. There the wiring is placed, connecting the relays together in a compact but accessible place. A plate covers the wiring so that none of the wiring on this part of the switch is exposed. The few wires which feed the magnets and wipers pass through a single hole in the base plate. The base plate carries also the switch frame, in which the certical, rotary, and release magnets are mounted.

The adjustment of an automatic switch may be divided into two parts, the relay adjustment and the adjustment of the motor magnets. Every relay is adjusted to a definite armature-stroke with a fixed residual air-gap. The amount of contact that each spring makes with its mate is likewise fixed. These distances are measured with thickness gauges placed between the armature and the pole of the magnet.

The contact springs of each relay are given a tension which is measured in terms of the operating and non-operating currents. Thus the spring tension is kept within limits.

The motor magnets (vertical, rotary, and release) are adjusted in a definite sequence to the proper relations to the wiper-shaft. These relations are also expressed in distances, most of them measured by thickness gages.

The final performance of the complete switch is tested by being operated over a line under conditions worse than any imposed by commercial use. The calling device delivers impulses at 14 cycles per second with an impulse ration of 61 per cent (circuit opened 0.61 of total impulse period.) One test employs a line of zero loop resistance with a 20,000-ohm leak across it. The other test employs a 1200-ohm line without leakage.

The spring tension of the motor magnet armature is adjusted so that perfect operation is secured under these two extremes of line conditions, with the battery voltage between 46 and 49 volts.

The control of automatic switches over the subscriber line is a telegraph problem. The elements involved, Fig. 4, are the line circuit, the release relay circuit, the motor magnet circuit and the release magnet circuit. All but the line circuit are wholly within the central office where the conditions are constant. Each element contributes its share toward fixing the line characteristics which are necessary for operating a switch.

The normal operation is as follows: The calling device springs (*CD*) are opened and closed as many times as there are units in the digit being transmitted. The line relay (*LR*) follows these impulses. The release relay, (*Rel-Ry*) having a copper collar remains energized during the series. The series relay pulls up the first time the line relay falls back and remains energized during the series of pulsations to which the magnet (*VM*) responds by moving the wiper shaft the required number of steps. At the end of the group of impulses, the line relay comes to rest energized, the series relay falls back and causes the local circuit to be changed to suit the next action.

The period of an impulse Fig. 5 is the time from the opening of the line to the next opening of the line. It includes a "break" and a "make." The upper line represents the time that the line current is flowing. It is shown as broken three times, as in sending the digit "3". Each opening of the line produces one pulsation to the magnet. This is represented by a line just below the break in the line current. Owing to the delay of the line relay in obeying the current, there is a little time-lag at the beginning and at the end of each pulsation.

The impulse ratio is the ratio of the time that the line is opened to the total period of the impulse. Applied to the magnet, it is the ratio of the time of current flow to the total period of the impulse. Formerly a fifty per cent (0.5) impulse was used. It has been found that a longer opening of the line circuit gives greater certainty to the selection, so that sixty-one per cent (0.61) is now used. The reasons are discussed below.

The release relay must be held energized continuously, because when it falls back it will cause the switch to release. The greatest break in current which the release relay can stand without letting go is about 77 per cent. (For a group of 10 impulses at 10 per second.) At the beginning of a group of impulses, the release relay is fully energized. While the line relay armature is vibrating, the release relay is kept energized by pulsations fed to it, one pulsation each time the line relay pulls up. If these pulsations are short, the magnetism will not be fully restored each time gradually run down. There is always enough magnetism remaining to hold the armature to the end of ten impulses. The aging of a slow acting relay (equipped with a copper collar) always tends to make it hold better.

The series relay must also remain energized as long as pulsations are being sent to the motor magnet. The shortest pulsation which it can have is about 28 per cent for ten pulsations at 10 per second. The conditions which supply long pulsations to the series relay, give short ones

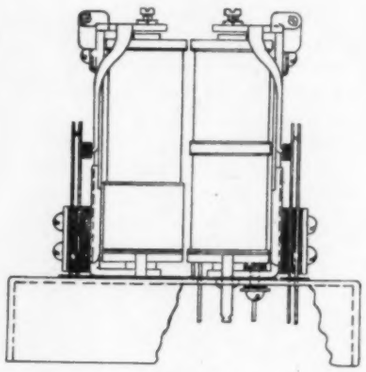


Fig. 3—Automatic Relay Mounting (Top View)

to the release relay. But the short pulsations which each can endure give a large range through which the ratio can vary without causing either relay to cease to function properly.

The vertical magnet requires at least a 27 per cent pulsation and not more than 86 per cent for satisfactory operation under the same conditions. Being in series with the series relay, it gets the same impulse ratio. Since

the magnet has considerable work to perform, it can stand a very high ratio.

The rotary magnet of a connector can stand a variation of impulse ratio from 30 per cent to 95 per cent.

The total performance of the automatic switch is judged from the standpoint of the subscriber's line. Ordinarily a switch is adjusted to work over lines of varying length. This is because any telephone may use almost any switch. Sometimes a switch is to be used on one line or trunk only; in this case the line relay can be adjusted to operate on a 2500 or 3000-ohm loop. When adjusted for such a loop it would not work well on a low resistance loop (300 ohms and under). Loop resistance of the subscriber's line does not include the telephone instrument because in an automatic telephone the talking apparatus is cut out during the dialing period.

If the subscriber line is of zero length with no leakage or capacitance, the impulse ratio may vary from 38

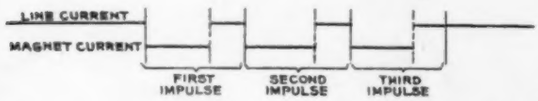


Fig. 5—Impulses

per cent to 71 per cent without causing the switch to fail.

The effect of simple line resistance is to lengthen the pulsation delivered to the motor magnet, and shorten the pulsation to the release relay. This results in weakening the release relay so that it may start to fall back near the end of a ten impulse digit and if the line resistance be excessive may even cause premature release. If the loop is 500 ohms, the impulse radio may vary from 36 per cent to 72 per cent without causing the switch to fail. If the loop is 1000 ohms, the limits are 35 per cent and 68 per cent. The margin for safety is ample.

The practical safe limit for a subscriber's line is a loop resistance of 1000 ohms. This is a greater resistance than is necessary for good common battery transmission, so that any loop which is low enough in resistance for good transmission is good enough for automatic dialing.

The effect of line leakage is to cause the line relay to be slow to fall away and prompt to pull up. This gives the motor magnet and its series relay a shorter pulsation, so that there is less power available to move the switch and a greater likelihood of the series relay not remaining energized throughout the group of pulsations. The practical limit of leakance is about 50,000 ohms for the subscriber's line, measured between wires or from either wire to earth. Since the switches are adjusted to operate perfectly with a leak of 20,000 ohms across the line, the factor of safety is ample.

Distributed capacitance such as found in telephone cable exerts no bad effect upon dialing. A capacitance between the two conductors has a tendency to delay the relay in falling back, and thus to shorten the pulsation delivered to the motor magnet. This partly neutralizes the effect of line resistance. In fact, the capacitance may be increased to seven microfarads without causing the automatic switch to fail.

Lumped capacitance, as found in telephone instruments on a party line, affects the dialing. It is more correct to say that it is the inductance of the bell in connection with the capacitance of the condenser that influences the signals. For this reason the capacitance of condensers used with harmonic bells (5 bells on one party line) is made .07 microfarad. With this value at least two more bells could be used without causing any failure of dialing.

In general, line faults have the same effect upon an automatic switchboard that they have upon a manual switchboard. The chief effects are compared in the table following.

Manual	
Open.	No calls, no indication
+ *L* grd.	Line noisy, conversation poor
— *L* grd.	Permanent signal
sht. ckt.	Permanent signal
Automatic	
No calls, no indication	
Line noisy, conversation poor	
Dialing bad, sometimes impossible	
Permanent signal	
Permanent signal	
Crosses between lines.	
+ *L* and + *L*	Cross talk
— *L* and — *L*	Cross talk, two line signals shows when one calls
+ *L* and —*L*	Permanent signal on one line
Cross talk, a second trunk occupied b no trouble	
Cross talk, a second trunk is occupied wh one calls	
Permanent signal on one line	

A rotary line switch has been produced which beside giving access to 25 trunks possesses other advantages. It was the equipment furnished by the Automatic Electric Company for the automatic telephone exchange at Orleans, France. Its chief use in America is in the community automatic exchange.

Periodic ringing is the accepted practice, on both individual and party lines. If the subscriber removes the receiver from the hook, the ringing current is cut off at once, even if it occurs during a time of ringing. The cut-off is quick enough to be complete before the receiver reaches the ear.

Party lines are segregated and served by party line boards, one hundred lines per board.

The preferred practice is to provide a party line board with four or five groups of connectors, each group being supplied with a different frequency of ringing current. Each subscriber line is multiplied to all these groups of connectors. The hundreds digit of the call number selects the group of connectors and therefore fixes the frequency which shall be

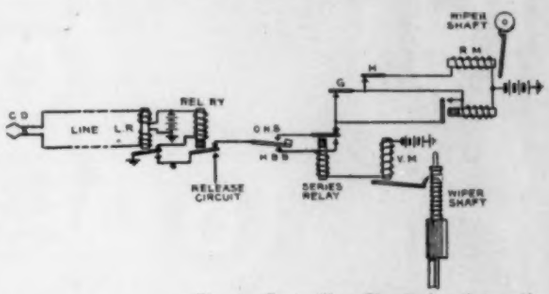


Fig. 4—Controlling Circuit for Automatic Switchboard

used. The last two digits control the vertical and rotary motions of the chosen connector as usual. Any group of connectors can equally well connect to the desired line, but the bell which rings depends upon which group of connectors is used.

An alternative method is to have but one group of connectors per hundred lines and to equip each connector with a frequency selecting device which is operated by the last digit of the call number. It makes each call number one digit longer, but is somewhat cheaper as to initial cost.

Telephone service for intermittent users (other than regular subscribers) is usually furnished by stations equipped with some form of coin collecting box. For local service, the rate is displayed near or on the telephone instrument together with directions for its use. For toll or long distance service, the user must call for the toll board to receive supervision and information.

The automatic telephone has been successfully equipped with "nickel-first" and "nickel-last" coin-boxes With the former, the deposited coin is held until the called station answers, then a reversal of current operates a polarized relay in the coin-box which collects the money. With the latter, the user dials the number as usual, the answering of the called station reverses the battery current which operates the-polarized relay in the coin box, the latter short circuits the transmitter and shunts the receiver enough to prevent its use as a transmitter, but still permits hearing that the called station has answered. Depositing the coin clears the transmitter and receiver.

A credit meter is also in use, which records the number of completed connections. It may be attached to the instrument and worked with a push-button (instead of a coin) or may be located apart from the telephone on the subscriber's premises and require no act of the subscriber. An older type of meter is designed to be located in the central office.

If the pay station be used to call a free local number, no current reversal will take place. All free lines are connected to a group of connectors which do not reverse the current when the called station answers.

When the user of a pay station desires an out-of-town connection, he dials the toll recording desk as any local subscriber would do. When the connection is ready, the line operator calls the pay station automatically, requests the payment, and is by sound notified of the deposit of the coins as is the case in manual practice.

Durability. The durability of automatic equipment is attested by the performance of the older plants. A group of ten exchanges scattered over the Union, were installed from May 1903 to December 1904. These exchanges are still (1919) in operation. Their original joint capacity of 19,476 lines has grown to more than 104,000 lines. The original equipment is still in use. During about fifteen years of service, the regular maintenance has been able to keep the apparatus in good shape. Today the cost of maintenance material for the switchboard per line per year is from 7 to 9.5 cents, and for the calling device 2 cents per year.

Maintenance. The proper maintenance of any machine requires that it shall be prevented from deteriorating. It is cheaper from every reasonable standpoint to keep it in good working order than to neglect it until its condition is so bad that it has adversely affected service. Each function should be tested at such intervals as have been found necessary to give good service.

In public exchange the routines involve inspections occuring daily, weekly, monthly, quarterly, twice a year and yearly. The daily, weekly and monthly routines are merely precautionary inspections, they are not adjustments.

The daily routine includes a rapid inspection of the functions of selectors. Once a week there is a rapid inspection of the line switchboards and of the functions of connector switches. Once a month the alignment of line switch plungers is examined, and the dust cleaned off the switch covers, tops of bays, etc.

Every three months the selector trunks are tested (continuity of bank and terminal wiring, particularly of infrequently used or overflow trunks and switches), wiper cords are examined and replaced if necessary, master banks and wipers are cleaned and inspected, and alarm relays are inspected and adjusted.

Twice a year the contact springs of relays and other devices are inspected for proper movement and tension and brought to standard. The switches are tested for operation under extreme line conditions. Switch shafts and master switches are cleaned and oiled. Banks are cleaned and wipers adjusted and replaced if worn. A rapid inspection is given to the rotary motion of selectors. All equipment is tested for freedom from grounds on frames and supports.

Once a year everything is checked up for conformity to standard and brought to standard. This includes the ratchet mechanism (vertical, rotary, and release) of each selector and connector, the repeaters, the line switch plunger alignment and its bank contacts and the cut-off relays.

The maintenance of an automatic exchange requires the attendance of persons who know what to do and when to do it. The average mentality required is not higher than for a manual plant of the same size.

A single office exchange having 2300 lines and 5500 subscribers telephones requires approximately the following force for maintaining the central office equipment.

One switchman.
One service clerk.
One line tester.
One information and complaint clerk.
One night man (answers toll board in addition).

A two-office plant having 5400 lines and 10,000 telephones requires the following central office force.

One service chief.
One switchman.
Two apprentices.
Two service clerks.
One tester.
Two information clerks.
Two assistant clerks (also take care of complaints).

The telephones can be increased to 13,900 without adding to the central office force. A service chief has charge of the switch room and does work on equipment. A switchman makes adjustments and repairs. An apprentice performs routine tests, supervises signals, and answers telephone calls to the switch room; an apprentice may be in training to become a switchman. A service clerk is a girl who performs the same duties as an apprentice. A tester makes tests on local and long distance lines; and in a small plant may act as dispatcher, routing the outside troublemen. The duties of information clerk are the same as in a manual plant. The employment of girls to perform routine tests has become a factor in exchange maintenance. They learn easily, are quick and careful in their work, and are proving very satisfactory.

Cumberland System Absorbs Memphis Company

Announcement is made that the merger between the Cumberland Telephone and Telegraph Company and the old Memphis Telephone Company has been completed and the formal acceptance of the consolidation filed with the city commission of Memphis, Tenn.

The Memphis company's property will be taken over by the Cumberland by the terms of the merger.

Indiana Association Is Now a Corporation

The Indiana Telephone Association, an organization which has been in existence for several months, has been incorporated. Articles of incorporation were filed with the secretary of state by Claude R. Stoops of Napanee, William M. Bailey of Richmond and Frank O. Cuppy of Lafayette.

Telephone Repeaters

Presented at a Joint Meeting of the American Institute of Electrical Engineers and the Institute of Radio Engineers—Continued

THE application of the principles involved in direct and alternating-current generators to the solution of the telephone repeater problem received the attention of some of the best minds in the art during the decade following 1900. During this time the problem was attacked both theoretically and in experimental design by H. S. Warren, M. I. Pupin, and others. The practice of power engineers suggested two typical methods.

(1) A generator of which the armature should constitute the output circuit of the element and the field winding the input circuit. Variations in the field current will result in corresponding variations of the armature voltage of such a machine. In order, however, that there should not be present in the armature voltage variations due to commutation, which would result in extraneous noise in the telephone, it is necessary that such a machine have a high frequency of commutation. If this frequency is well above that of the highest frequency which is essential to the faithful reproduction of the human voice, the noise currents due to commutation may be choked out by inductance or filtered out by a periodic structure like an artificial loaded line. When it is said that frequencies of 2500 cycles per second are required for good quality of telephone speech it is evident that for any practical design of armature and commutation the peripheral speed must approach the allowable mechanical limit.

Various unipolar designs were therefore considered in which no commutation is required. The principle involved may be seen by considering Fig. 10 which shows a form suggested in 1905 by G. A. Campbell.

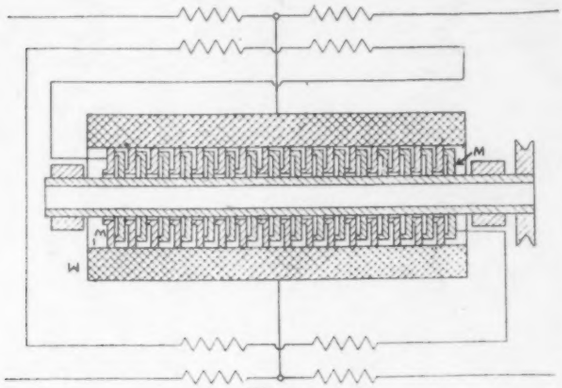


Fig. 10.

The field coil M is solenoidal and carries fixed disks, w', which serve both as a magnetic core and as collectors for the radial e. m. f's. induced in similar disks, w, attached to the rotating shaft. In machines of this character where the field current is only of telephonic magnitude the flux is very small and the e. m. f. which may be obtained at any mechanically allowable speed of rotation is much below that requisite for a successful telephone repeater. In addition the eddy current and hysteresis losses are relatively high because of the frequencies involved and the efficiency is correspondingly low. The input impedance, being that of an electromagnet, is not independent of the frequency, as is desired, but instead is such as to discriminate against the higher frequencies of the voice wave.

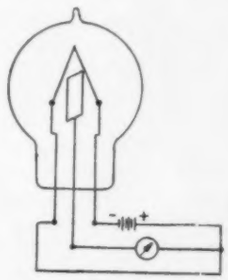


Fig. 12

Even if it were possible to build and operate such high-speed generators as repeaters of feeble currents, the type is deficient in so many of the characteristics required of a successful commercial repeater that the extent of its use is questionable. Now that simpler and practically perfect repeaters are available, it is doubtful whether the limits of physical possibility in this type of apparatus will ever be worked out.

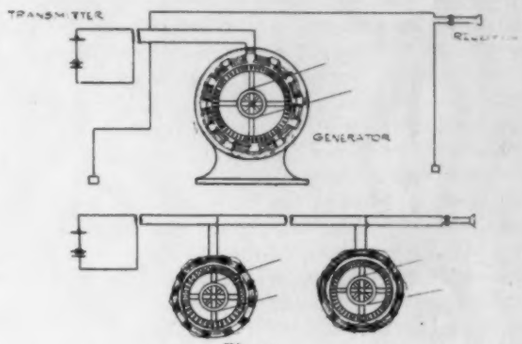


Fig. 11.

(2) The practical difficulties of eddy current and hysteresis losses, of limiting speeds and of small input, were also effective in preventing the development of a successful repeater along the lines previously followed in the power engineering of alternating currents.

(3) In 1900, Joseph Lyons disclosed to us his invention, a telephone repeater upon the principle developed and patented in power engineering by Hutin and Leblanc. The principle is perhaps better known as that of the asynchronous generator, which is an induction motor driven above synchronism by a local source of mechanical energy. The conditions under which such a device may serve to supply energy to a transmission line, across which it is connected, are well known to electrical engineers. It was Lyons' idea that the stator should be bridged across a telephone line and, through the interaction of the

received current with that induced in the short circuited rotor, should supply to the line additional energy of the same wave form as it received. Schematicaly the circuit is as shown in Fig. 11.

In order, however, to supply energy at any telephone frequency the speed of the rotor must be at least as large as the quotient of the given frequency and the number of pairs of poles in the stator. Thus in the case of a 12-pole stator a frequency of 2,400 cycles per second would require a speed of 400 revolutions per second. Not only are the speed requirements too high for practical operation but the machine would also fail to meet the second requirement for a repeater. The amplification for each frequency would depend upon the negative slip at that frequency and thus the lower frequencies of the voice current would receive more amplification than the higher ones. It was at one time suggested by Dr. Pupin that such distortion might be avoided by using several such asynchronous generators connected at different points of the line and each designed to amplify but a band of frequencies. Even had it been found possible to devise efficient machines to amplify the different groups of frequencies, it is doubtful if the arrangement would ever have proven satisfactory in an operating telephone plant, since at no point along the line between the first and last generator would the current have represented normal speech. This characteristic of the system would, of course, be a serious handicap to proper operation, since it would be almost impossible to tell whether the line were in trouble or not.

That the mechanical limitations of speed, clearance, thickness of lamination, and the other factors familiar to designers of dynamo equipment should have prevented the development of such a generator is understandable

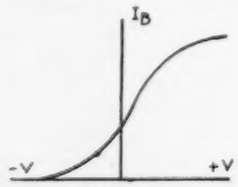


Fig. 14

when the telephone requirements are stated in terms of power engineering. What was required was a generator which could operate on about one-half of a milliampere of field current. To give an energy amplification of 256 times, its field losses must be less than one per cent of the output. The value of one-half of a milliampere is the effective value of a complex wave form, all the sinusoidal components of which must appear in the output with equal amplification.

II. Electric repeaters are those in which the moving parts are discrete

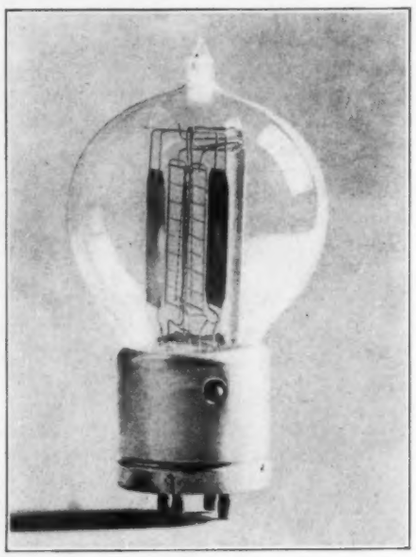


Fig. 13.

electrons whose motions are unimpeded by molecular matter. Such devices, therefore, require a vacuum sufficiently high that the motions may be characteristic of free electrons. There must also be a means of supplying free electrons, that is of dislodging them from molecular matter of which they form constituents. The satisfactory method of accomplishing this is to "boil them out" of a piece of metal or metal oxide. Our present electronic repeaters are therefore "thermionic" devices.

The history of thermionics may be said to date from the publication in 1902-1903 of papers by O. W. Richardson in which he advanced a theory of the thermionic emission of electrons, which in all its essentials was accepted by the great majority of the scientific world and may now be regarded as definitely established. According to this theory (which is also a theory of metallic conduction) metals and conductors of electricity contain within their bounding surfaces immense numbers of free electrons which behave like the molecules of a perfect gas. When a metal is heated the kinetic energy of the electrons is increased and the number escaping across the boundary surface is likewise increased.

J. J. Thompson outlined the theory in his treatise on conduction of electricity through gases as follows:

"The emission of corpuscles from incandescent metals and carbon is readily explained by the view—for which we find confirmation in many other phenomena—that corpuscles are disseminated through metals and carbon not merely when these are incandescent, but at all temperatures, the corpuscles being so small are able to move freely through the metal and they may thus be supposed to behave like a perfect gas contained in a volume equal to that of the metal. The corpuscles are attracted by the metal so that to enable them to escape into the space surrounding it they must have sufficient kinetic energy to carry them through the layer at its surface where its attraction of the corpuscle is appreciable. If the average kinetic energy of a corpuscle, like that of the molecule of a gas is proportional to the absolute temperature, then, as the temperature increases more and more of the corpuscles will be able to escape from the metal into the air outside."

In 1904 Wehnelt discovered that the thermionic emission from conductors coated with certain oxides was enormously greater than that of pure metals. Since that date the study of thermionic emission has proceeded most rapidly and the practical applications of the phenomena have more than kept pace during the last eight years.

Phenomena due to thermionic emission had, of course been observed for years before a satisfactory theory was advanced. The first of the these instances was the discovery by Edison in 1884 of an effect which is now known by his name. He found that if a metallic plate is introduced into the bulb of an incandescent lamp and if the plate is connected to the positive terminal of the filament then a current flows between the plate and the filament as may be observed by a galvanometer inserted as shown in Fig.

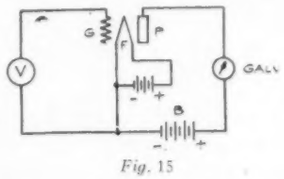


Fig. 15

12. This conductivity of the space between the plate and filament is unilateral, for if the plate is connected to the other terminal of the battery no current flows. The explanation of the phenomenon resulted from work

of Fleming in 1896 and J. J. Thomson in 1899 along lines earlier pursued by Elster and Geitel. Fleming studied the operation of a two-member vacuum tube device having a heated filament and cold plate, and Thomson demonstrated that the mechanism of current conduction between the filament and plate resulted from the emission of negative electrons from the filament.

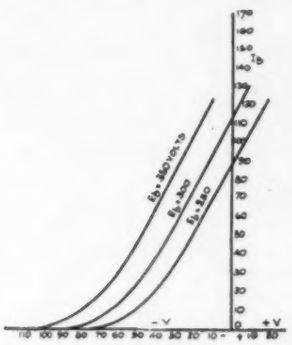


Fig. 16

Through such a tube a current may flow, since electrons may pass and will so do provided the plate is positive with respect to the filament and hence such as to attract the electrons emitted by the latter. The idea of using such a two-element device as a rectifier and hence detector of wireless waves was applied independently in 1905 by Wehnelt and by Fleming.

For the next few years practical progress with thermionic devices was in the hands of the radio-engineers In his American Institute of Electrical Engineers' paper of 1906 De-Forest showed that the discharge between the hot cathode and the plate can be controlled by additional electrodes. In a patent issue the following year he shows inside the bulb such a controlling electrode to which he had given the form of a grid. With his discovery of a means for controlling the electron stream was born the most sensitive of repeating elements. Years of careful technical development were required, however, before the original idea had been perfected to the point where it met fully all the rigid requirements of application in a commercial telephone plant.

To understand the development which was required to adapt the first successful form of audion designed for radio-telegraph receiving to this use, we shall first consider in some detail the structure and physical principles of the device.

The "audion" consists of an evacuated vessel containing three electrodes from one of which a thermionic emission of electrons is obtainable. Fig. 13 shows the characteristic structure. The filament is heated by the passage of a current as shown diogrammatically in Fig. 14. The other two electrodes are a plate and a grid. If a battery is connected to the filament and plate as in Fig. 14, so as to make the latter positive with respect to the former, then a current will flow in the circuit so formed. The electrons emitted at the filament are drawn across the intervening vacuum by the electrical field which the battery, B, in the plate circuit establishes. If an e. m. f. is now applied between the grid and the filament as by the source marked V in the figure, the field between plate and filament is altered and the current in the plate circuit is correspondingly altered. If the grid is made positive with respect to the filament more electrons are urged across the space between grid and filament. While some of this increase strikes the grid, and thus results in a current in that cicuit, by far the greater number continue through the meshes of the grid to the plate. The result is an increased current in the plate circuit. Conversely, if the grid is made negative there results a decrease in the plate current. In this case, however, no current flows in the grid circuit because electrons can be drawn to an electrode only if it is positive with respect to the source of the electrons.

The characteristic relation between the grid voltage, V and the plate current I_B, is that of Fig. 15. If the plate voltage is altered the form of the curve is not altered but the magnitude of the current is changed as illustrated in Fig. 16 which shows a family of such characteristics. It is evident

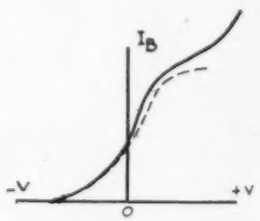


Fig. 17

from this figure that the number of negative volts which must be applied to the grid in order to reduce the plate current to zero is always the same fraction of the volts applied in the plate circuit. Hence it appears that the current in the plate circuit may be altered either by altering the voltage there applied or by a much smaller alteration of the voltage applied to the grid circuit. The device thus gives a voltage amplification.

As long as the grid is kept negative no current can flow in that circuit and any alterations in its voltage are unaccompanied by any current variation and hence are entirely wattless. Such variations are accompanied by current variations in the plate circuit and result in an energy expenditure in that circuit. The telephone efficiency is thus seen to be practically infinite since an energy output may be obtained by a wattless variation of the input voltage.

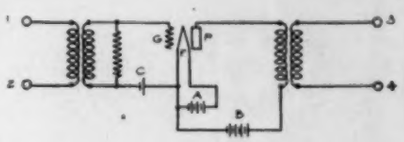


Fig. 18

To understand why the characteristic curve of Fig. 15 flattens out as the grid is made more positive we need only to remember that in the passage of a current through the plate-filament circuit two physical phenomena are involved. The first of these is the thermionic emission of electrons at the filament and the second is their enforced and directed transit between filament and plate. The emission takes place whether or not a voltage is impressed on the plate-filament circuit, and depends only upon the filament temperature. The process is much like evaporation in a closed vessel and soon reaches a statistical equilibrium were electrons are leaving and return to the filament at the same rate, that is number per second. Impressing a positive potential on the plate disturbs the equilibrium for it withdraws electrons from the tube. When this voltage is small it withdraws but a relatively small number per second; that is the current is small as in the lower portion of the characteristic. As the voltage is increased the current increases but reaches a steady maximum value for a voltage sufficient to draw across the interspace as many electrons per second as the filament can emit at the operating temperature.

Although the number of electrons per second which pass between filament and plate and hence the current is so limited, the velocities with which the individual electrons move will continue to increase with the voltage. If there is a residual gas in the tube its

molecules will be ionized by their collisions with the electrons provided the velocities of the latter are sufficiently high to disrupt the electronic systems of which these molecules are formed. Such ionization, however, increases the number of electrical carriers and hence the charge per second which may be transferred. The presence of gas in a tube is in general, therefore, evidenced by such a characteristic as the full line of Fig. 17.

The voltages involved in the detection of radio signals are much smaller than those met with in telephony so that no serious inconvenience arises from the presence of residual gas. As a consequence, in the production of his early successful audions for radio reception DeForest did not find it necessary to employ all of the known means for producing the highest possible vacuum.

In dealing with the very much larger energies which obtain under the conditions of telephonic repeater action, it is necessary to adopt methods of manufacture which will insure the removal to a high degree of all gaseous material in the tube, including that which may be occluded in the walls of the tube or the enclosed metallic parts. When such evacuation is accomplished all of the advantages

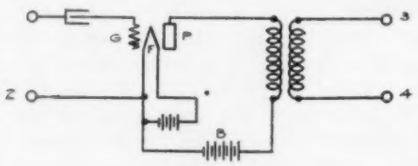


Fig. 19

of a pure electron discharge are retained, even for the higher voltages and currents which have to be dealt with in a telephone repeater. In other words, for a given plate voltage there is obtained a wider range of voltage which may be impressed upon the grid without departing from the true thermionic character displayed in Fig. 15.

In addition to securing the necessary conditions in this respect, a large amount of research work has been done by the engineers of the Bell System in producing suitable forms and proportions of tubes to give the best results with the various types of repeater circuits and in devising a type of filament which will insure a maximum of life and a minimum of power consumption for the amplifying tube and at the same time insure a uniform operating characteristic throughout the life of the tube. Further than this, the work has resulted in ability to produce in quantity tubes of exactly the same characteristics, a feature which is of the utmost importance in telephone repeater operation but which is of minor importance in radio work. Non-uniformity in the tubes would very seriously handicap

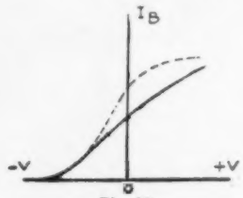


Fig. 20

the commercial operation of this type of amplifier since it would require the readjustment of apparatus each time it might become necessary to replace a worn-out or damaged tube.

Not only was the original form of audion deficient as a telephone repeater from the standpoint of its energy capabilities, but the conditions of its use in radio reception were inherently different from those which obtained in a telephone repeater circuit. We may express this fact by saying that for radio detection we make use of the ability of a device to distort a sinusoid, which is impressed upon it, while for telephonic purposes we require the very minimum of distortion.

Associated with the audion in DeForest's use was a condenser in the grid circuit as shown in Fig. 18. The input terminals were *1* and *2* of that figure and the output terminals were *3* and *4* of the repeating coil. If employed as the amplifier in a telephone repeater, the repeating coil serves to impress on the telephone line to which the device is connected the variations in the plate circuit current from the Battery *B* which may be occasioned by any alterations in the potential applied to the input circuit. The condenser, however, serves as an electron trap if a sinusoidal e. m. f. is impressed on terminals *1*, *2*. Thus imagine that the first half wave of the sinusoid makes the grid negative with respect to the filament. This polarity tends to force electrons from the grid to the filament, but, since electrons are not emitted by the grid, no transfer takes place. Making the grid negative does, however, reduce the current though the plate circuit as we saw in connection with Fig. 15. Now, the succeeding half wave tends to force electrons in the opposite direction, that is from filament to grid, which is a possible direction of transfer in this unilateral circuit. The individual electrons so transferred to the grid cannot pass through the condenser and complete the journey back to the filament although others from the opposite plate of the condenser may be induced to make the rest of the journey. The result is that each positive half wave increases the number of electrons on the grid and its adjoining condenser plate and thus results in a further increase in negative potential. But the more negative the grid becomes the smaller is the current in the plate circuit and the lower the point on the characteristic curve about which we are producing sinusoidal variations.

Obviously, such an action is very satisfactory for detecting the presence in the input circuit of a train of sinusoidal waves of small amplitude since the effect is cumulative. Equally obviously, however, such action may absolutely prevent the passage through the system of a voice actuated train of waves since a word or two may make the grid so negative as to reduce practically to zero the plate current upon the variations of which the transmission of the wave depends.

The correction of the circuit arrangement by the elimination of this condenser, which aided distortion, was but a detail in the broader research which we have made on the application of thermionic devices. This work involved a study of appropriate circuits in which these tubes could be used, of thermionics, of methods of producting high vacua, of gages for indicating the degree of vacuum obtained, a study of various types of filament to secure efficiency and uniformity, and of the physical relations in three-element vacuum tubes of the

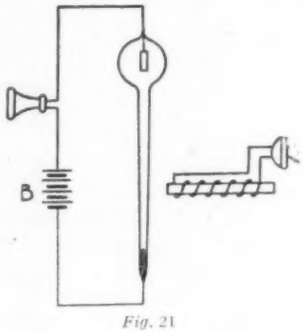


Fig. 21

geometrical form and separation of the electrodes. Some of these researches as for example those of Van der Bijl, W. Wilson, and others have already been published.

The net result of these researches has been our ability to design and construct tubes adapted to any of the purposes of the art of communication.

In the final form in which we use a vacuum tube as a telephone repeater we obtained a characteristic relation between input voltage and output current which is free from distortion as far as we can recognize such effects. This is obtained partly by the design of the tube and partly by the proper

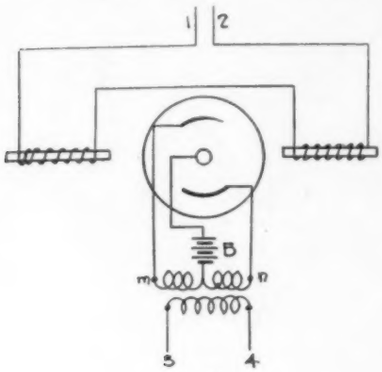


Fig. 22

adaption to it of its associated circuit.

In the first place we arrange that the repeater shall have a constant and finite input impedance by bridging between grid and filament a high resistance. To this resistance current is supplied by a step-up transformer as indicated in Fig. 19. The voltage effective in the grid-filament circuit is then the drop across the resistance. In the second place we generally arrange that the grid shall not be positive at any time in the cycle of the impressed voltage. This is accomplished by inserting a battery, *C*, in the grid circuit. In this way the tube acts as a device for amplifying the impressed voltage and introduces no distortion due to the unilateral conductivity of the grid circuit.

The characteristic relation between grid voltage and plate current which is shown in the curves of Fig. 16 is obviously not that of a perfect repeater since there is not a linear relation between input voltage and output current. The voltages indicated on these curves are those of the battery in the plate circuit. The condition under which they were obtained is that of no external resistance in this battery circuit so that the voltages are really those which are effective between the plate and filament within the tube. The values of the current in these plots are due to the combined actions of this effective voltage and of the voltage impressed upon the grid circuit. For each of these curves the effective plate voltage is constant and the curve gives the relation between the input voltage and the output current. If, however, there is external resistance in the plate circuit, then the effective voltage between the plate and the filament will not be that of the battery, but will be less by the amount of the *IR* drop in the external circuit. An increase in the grid voltage will not, then produce as large an increase in plate current because such an increase as it would produce if the plate voltage was constant is partially neutralized by the decrease in the effective plate voltage which the *IR* drop occasions. The result is that by properly proportioning the external resistance of the plate-filament circuit we may obtain a characteristic relation between grid voltage and plat current which is essentially linear as shown by the full line curve of Fig. 20.

The requirements for a telephone repeater stated above are thus fully met in our construction of the audion and in the circuit arrangement for its operation. In later portions of this paper we shall meet illustrations of its perfection in the report of experiments and commercial operation.

In the case of the audion the control of the electron stream is electrostatic. It is possible, of course, to control such a stream by electromagnetic means since the stream is really a current. Such a control, is, however, inherently less efficient and sensitive than that of the voltage actuated device described. We shall, therefore, give no detailed discussion of such methods but will pass at once to the discussion of devices in which the presence of gas molecules results in an ionization and the consequent presence in the tube of positive carriers of molecular size as well as negative electrons.

III. The distinction between electronic and gaseous repeating elements is not a matter of the presence or absence of gas since an absolute vacuum is unobtainable. It is rather a matter of whether or not gas is an irrelevant and undesirable element or an indispensable one. In the vacuum tube of DeForest gas was not indispensable as we have seen and such gas as was residual limited the range of voltages, throughout which the tube had the desired characteristics when used as a repeater.

III-A. In the repeating element of Von Lieben which was invented in Europe somewhat later than the time the audion was produced here, gas is an essential constituent. This device has a Wehnelt cathode, that is a filament coated with oxides of the alkaline earths from which electrons are thermionically emitted. The function of the cathode is not, however, to provide all the carriers as in the case of the filament of the audion but rather to provide means for ionizing the gas present in the tube.

The tube is a three-element device and has in addition to the thermionic cathode, an anode of aluminum (corresponding to the plate of the audion), and an intermediate sieve-like electrode in the form of a perforated aluminum disk.

The function of the sieve is to control the discharge which takes place between the anode and the cathode, in case a potential is properly applied. The stream of electrons which proceeds from the cathode to the anode is impeded by the presence of gaseous molecules. The consequent collisions will result in the ionization of some of the gas molecules if the velocity is sufficiently high and this velocity depends upon the potential which is applied to the circuit. The ionization results in the presence of more electrons which are available for increasing the current and also in the presence of positive ions of molecular size which are similiarly available but move in the opposite direction. The introduction of a potential between the filament and sieve permits of an external control of the motions of the electrons and positive ions, attracting the former and repelling the latter or vice versa.

Small changes in the potential applied to the sieve may result in relatively large changes in the ionization

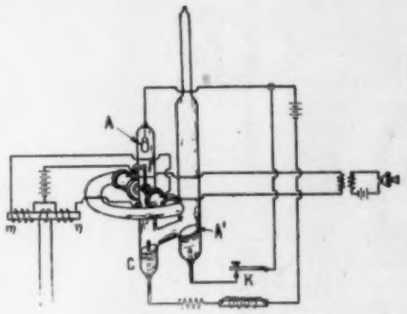


Fig. 23

and hence in the current in the anode circuit. The device may, therefore, be used to give amplification but for reasons which will appear presently it is not adapted to telephonic work.

Since the tube contains carriers of both kinds a stream of one kind or the other will inevitably flow to the sieve and thus there will be a current

in that circuit which will depend for its direction upon the polarity of the applied voltage and for its amount upon the conductivity of the gaseous space within the tube. If the cathode and sieve are used as the input circuit, corresponding to the filament-grid circuit of the audion, then it is evident that the impedance of this input circuit will vary with the impressed voltage. Such a variation will result in a serious distortion and is not in conformity with our requirements for a repeating element.

The presence of both kinds of carriers makes impossible the simple expedient which is so valuable in the case of the audion where the unilateral conductivity of the grid-filament circuit is utilized. Further the pressure of the gas within the tubes is subject to fluctuations which it is almost impossible to control. This results in large variation in amplification. In comparison with the electronic device the von Lieben tube is seriously deficient as a telephone repeater, and the electrostatic control of gaseous devices has not been found capable of as efficient and simple application to telephonic problems as is the electrostatic control of electronic devices.

III-B. The electromagnetic control of gaseous devices has likewise been investigated for telephonic purposes. The oppositely moving streams of positive and negative carriers will be deflected in the same direction by an electro-magnetic field. Provided that the motion of such a discharge stream may be made to alter properly the conductivity of either the circuit of the discharge itself or of some auxiliary circuit a repeating element may be formed.

Some of the early work on such systems is that of Hewitt whose experiments on mercury vapor arcs are well known. The method which he proposed to employ may be seen from Fig. 21, where is shown a tube containing mercury vapor through which a current is passing from the battery *B*. A receiver is connected in series with the battery and the arc. The arc stream itself is controlled by the electromagnet which is excited by the transmitter. This arrangement, which is essentially a very insensitive unilateral repeating device, has never, so far as is known, been made to function as a telephone amplifier. In addition to its inefficiency, this arrangement is undesirable because of noise, distortion and variable amplification.

A later step in the development of an electromagnetically controlled mercury arc repeater was taken by Dr. H. D. Arnold. He utilized an auxiliary circuit for the output and so disposed it that its conductivity was altered in conformity to the motion of the arc stream. In the general idea of using a mercury arc stream and influencing it magnetically, Aronld, of course, follows Hewitt.

The auxiliary circuit devised by Arnold is at right angles to the arc stream and includes three electrodes, one about the center of the stream and the other two approximately equally spaced on opposite sides as shown by a cross section of the tube in Fig. 22, the main arc stream being perpendicular to the plane of the diagram. The electromagnet is in the plane of these electrodes and thus serves to deflect the main arc stream toward one or the other of the side electrodes depending upon the polarity of the magnet. The ions in the main arc stream are available carriers for current between these electrodes and the central electrode if a potential is maintained between them as by the battery, *B*.

In the normal condition, when the arc is undeflected, similar portions of the arc stream are included between the center electrode and each of the side electrodes. The conductivity of the two paths thus offered to the potential of the battery are then equal and there is no difference of potential between the terminals *m*, *n* of the coil, to the center tap of which the battery is connected. In so far as the conductivities of these two branches of this bridge circuit tend to vary as the result of variations in the ionizations of the arc stream no difference of potential will be produced between the terminals of the coil, since both conducting branches will tend to vary similarly due to a common cause. Fortuitous variations in the arc stream are, therefore, not repeated in the external circuit and the difficulty of arc noise is practically eliminated. When, however, the arc stream is deflected by the voice actuated electromagnet, the conductivities of the two branches are oppositely changed and a resultant current circulates.

The device as originally described for patent is shown in Fig. 23. An auxiliary anode, formed by a mercury electrode shown at *A'* is used for starting the arc stream. In this form the arc is struck by tilting the tube and allowing the mercury of the anode *A'* to run into contact with that of the main cathode *C*. As the tube is resored to its vertical position an arc is formed between *A'* and *C*, provided that the key *K*, has been closed. Opening the circuit at *K* allows the arc to form between *C* and *A*.

This gaseous device is capable of good amplification and is fairly free from distortion except such as may be introduced by the fact that impedance of the electromagnet may not be identical with that of a telephone line. It was tried out experimentally on telephone lines but has never been used for any length of time and then only under special engineering supervision. For example, units were installed on the important long distance circuits between New York and San Francisco but were never used commercially.

(To Be Continued)

Inter-State Conduits Sold to City of Springfield

Purchase of the entire underground duct system in the downtown district of Springfield, Ill., formerly owned by the Inter-State Telephone Company, by the city of Springfield for a sum less than $5,000 has saved the municipality approximately $35,000 in carrying out its improvement program.

This was the statement of Commissioner Willis J. Spaulding when he made the announcement that the deal had been completed and the money paid to C. H. Rottger, general manager of the Central Union Telephone Company. The latter company recently absorbed the Inter-State company.

Negotiations for the purchase of the duct system, which covers the entire downtown district and contains 145,562 duct feet, began about three months ago, and it was only after a number of conferences that an agreement was finally reached. The cost of these existing lines to the city amounts to 3.4 cents per duct foot, while the estimated cost for new duct line would be 40 cents per duct foot. The city was able through the deal to save approximately nine-tenths of the purchase price for a new system.

Taking over of the old Inter-State company property will bring to the city a larger underground system than called for in the improvement program, which specified the need of 137,940 duct feet. The telephone company has already begun to remove its cables, which will be junked, to clear the way for the city to start installation of the electric transmission line.

Making Sales by Telephone

Methods by Which Telephone Subscribers Increase Their Business

By WILLIAMS WOLLER

GOOD morning, Mrs. James —Cornwell's speaking. May I have your order, please?"

"Oh, good morning, Miss Dyer. Yes; I'd like———" and here Mrs. James, or Mrs. Oliver, or Mrs. Roberts, or any of the other several hundred housekeepers who are on the regular "telephone list" of G. G. Cornwell & Son, grocers in Washington, D. C., rattles off a list of just what she figures she will need during the day.

When she has finished, or when she has replied, "I don't think that I need anything today"—Miss Dyer will remark, almost casually: "Did I tell you that we have a new shipment of olive oil in? It's the first that we've been able to get for some time and the price is considerably lower than formerly." Or she may refer to a kind of pie that the pastry department is featuring—the pastry department having replaced the wet goods side of the store since the District of Columbia went dry—or some other delicacy in which she has reason to think Mrs. James would be interested.

For years Cornwell's relied only upon its regular telephone system, taking orders when they were sent in and letting it go at that. Then a customer remarked one day: "Why couldn't you people call me up every morning instead of waiting for me to call you? I usually have a lot of things to do between 9 and

11, and frequently I forget to telephone. Some times, when I do call, your telephone is busy, and before I know it afternoon is here and I have to rely on the store around the corner for what I want."

The chief of the telephone section took the matter up with proper authorities, with the result that Cornwells' now has three girls who devote the greater part of every morning to ringing up customers, inquiring what they wish, and suggesting items. Each customer is called at the time most convenient to her, and it has been found that the profits on the sales of suggested items alone is sufficient to pay the salaries of the "suggestors." The telephone list is compiled primarily from the names of persons who have charge accounts, but the delivery department is instructed to keep a memorandum of all persons who make several purchases a week, that they may be solicited for a charge account with its attendant advantages both to the purchaser and to the store.

Cornwell's use of the telephone for the double purpose of contributing a cheery "Good morning!" and obtaining a number of valuable orders is only one of the many ways retail and wholesale houses in all parts of the country are selling customers they don't see. And every day is proving that the method is very well worth while, particularly when a single store in Philadelphia —Bonwit & Teller—has developed the idea to a point where they have a salesgirl with a $50,000 "telephone voice." At least she averages $50,000 a year in sales, and all she has to depend upon is her voice and the way she describes the goods.

Bonwit & Teller have found that it does not pay them to pick their lists of prospects at random from the telephone book. This might do very well for a neighborhood store which was just opening up, but not for an establishment which specializes in high-grade and rather expensive items of dress and adornment. The list, therefore, is compiled from the regular patrons of the store—women whose tastes in gowns and perfumes and lingerie is known and who are flattered by the personal appeal. It is a question of increasing the volume of purchases made by those who already deal with the store, rather than of adding to the number of patrons.

Accordingly, each of the Bonwit & Teller telephone clerks has her own special list—women with whom she is familiar, who rely upon her judgment and her taste. If, for example, she notes that one of her patrons is going to entertain quite extensively this winter she makes a mental note to keep her eyes open for dinner gowns, opera wraps, and the like, which would suit the style of this particular person. She also instructs the different departments to let her know when anything particularly new arrives and calls up Mrs. Rittenhouse at once, giving her name as well as that of Bonwit & Teller's over the telephone. Inasmuch as Mrs. Rittenhouse has learned by experience that the young woman's taste may be depended upon, the odds are immediately in her favor. And when the telephone clerk describes the gowns as only one woman can describe them to another and asks permission to send them up for her personal examination—well, what could any woman who is planning a series of social functions do but accept?

Of course, a considerable proportion of the ability of the "girl with the $50,000 voice" depends upon her knowledge of her patrons, what they like and to what they especially object. In other words, she banks heavily upon the element of personal

salesmanship and, in a surprising number of cases, she wins.

Somewhat the same plan is followed at the perfume counter of the same store. Here one of the salesgirls has been well trained in telephone selling as well as in feminine psychology. She knows there is nothing that the average woman wishes as much as a distinctive

scent—and "distinctive" is usually synonymous with "expensive." She also knows, by experience, how long it will take Mrs. So-and-so to use a bottle of perfume. Therefore, as soon as she makes a sale, she puts a card in her "tickler file" a month or six weeks distant, and on the proper date she calls up, inquires whether the perfume was satisfactory and, two times out of three, gets a reorder. The whole thing is so simple that the telephone division of the perfume department averages at least $20,000 a year—and very few of the patrons ever come near the store!

Another Philadelphia concern which makes excellent use of the telephone is the Knickerbocker Theater formerly known as one of the hoodoos of the entertainment business. But the telephone put it on the map. When the management changed hands, for the third or fourth time, a stock company was installed and three direct-line telephones were put in the lobby of the theater, with a sign calling attention to the fact that "This is our Special Department for selling tickets by telephone—polite, prompt service—call us up—Baring 323, 324, 325."

The three girls in this telephone box office have a comprehensive card index of all telephone subscribers in that section of the city and they call all residence telephones, delivering a brief but pleasant selling talk which covers all the features of the production, including the fact that the best evening seats cost only 50 cents and that all matinee seats are sold at a quarter. "Of course," they add to subscribers in the immediate vicinity, "the fact that we're within walking distance also saves your paying carfare to get to one of the down-town theaters."

As the telephones are also used for incoming orders, their numbers have been widely advertised in the theater programs in the **Knickerbocker** News, a small publication giving advance information of approaching attractions, and on bill posters throughout the city. These latter arouse curiosity by the brief message: "Why worry? Call Baring 323."

When it is mentioned that the Knickerbocker seats 2,100 people, and that ever since the present management took it over it has been playing to capacity houses, it will be seen that it pays to telephone.

A grocer in Wilmington, Delaware, finds the telephone particularly effective as a selling aid in stormy weather. Few of his customers have the hardihood to venture out in the rain or sleet, so he calls them up and says:

"Good morning, Mrs. Snyder: isn't this a terrible morning! I'm not surprised that you haven't come out. And since you can't come down town, I thought I'd call you up to ask if there isn't something I can do for you. Now we've got——"

The selection of people who are to be canvassed in a selling-by-telephone campaign rests with the merchant. He may use his telephone directory to obtain the names and telephone numbers of those he wishes for telephone customers; he may canvass the people who come into his store, or he may solicit orders over the telephone from persons who have been canvassed by his clerks.

One dealer, whose success in telephoning has been decidedly pronounced, started his campaign by making up a simple little card file which contained the names, addresses and telephone numbers of his prospects. On each card was written a list of articles indicating the tastes of each customer. He started to draw up a list of articles which could easily be sold over the wire, but he stopped when he realized that this would include practically everything in his store.

Then he started in to make his telephone sell for him. In a good many cases he found that the housewife was a bit flattered at being called; it seemed to please her to think she was considered a patron of such value as to warrant that sort of attention. Apologies were unnecessary; and the retailer soon discovered that he had been overlooking a good bet in failing to develop his telephone list before.

In fact, as Austin, Nichols & Co., wholesale grocers, point out in a salesman's letter:

"In order to increase the size of the telephone orders, a grocer in Ohio provides his cashier, who receives all telephone orders, with two lists of goods—one of staples usually needed, the other of 'fresh arrivals.' Then, when a patron orders some little want by telephone, or even sends in a good-sized order, the cashier tactfully mentions the fresh arrivals and often gets a big addition to the order, usually for fresh, perishable goods. Again, if the customers, in answer to the question, 'Anything else?' tries to think of other wants, the cashier's 'staple list' comes in handy. This grocer maintains that these two lists constantly before his cashier have almost doubled the average size of his telephone orders."

Bamberger's Department Store in Newark, N. J., has some interesting rules governing telephone example, the telephone clerks always ask, "May I take your order?" Greeting the customer with "Hello" is never permitted, nor is allowable to say "Bamberger's" or "Order department." Too many customers think that if they wish to order shoes or gloves they must be connected with the shoe or glove department. No clerk is permitted to make recommendations relative to merchandise ordered, it being impossible to introduce the personal element in a department where so many calls are handled. All orders are sent immediately to the division superintend-

ent of the department in question, for it is an ironclad rule of the store that telephone orders are to "clear" on the day they are received.

In the same room with the telephone order department is the "red telephone" operator, with her own switchboard. On each floor of the store in conspicuous places, are red instruments, each of which is a separate information bureau. They are for the use of customers who desire any information whatever about the store, even to its history, and not a few customers make use of these instruments to offer valuable suggestions.

Of course, there are those who ask "fool" questions, just for the joy of the thing. Not long ago a man's voice inquired over the red telephone, "Where can I find birdseed for a cuckoo clock?" And the operator replied, instantly and with perfect dignity, "We haven't any in stock just now, but if you will be kind enough to leave your name and address we will try to get it."

A click from the other end of the wire indicated that the caller had hung up, but he hadn't "gotten a rise" out of the telephone girl, as he expected. Seed for a cuckoo clock and other impossible items, however, are about all that is not sold over the extensive and well-regulated telephone system of "Market 1," a system that keeps twelve girls working all day long taking orders from customers in all parts of northern New Jersey.

Indiana Central Union Talks Huge Expenditures

Testifying before the Indiana Commission, E. S. Bloom, of Chicago, president of the Central Union Company said that the proper development of the company in Indiana during the next year would require the expenditure of about $3,000,000. When questioned by Commissioner Haynes in regard to the future development of the company he said that probably $25,000,000 or $30,000,000 should be expended by the company in the state during the next ten years in order to extend the lines and to give the quality of service demanded by the patrons.

Mr. Bloom said that tentative plans for the immediate development of the company in Indiana call for the extension of toll cables throughout the state. He said that a toll cable from Indianapolis to Anderson will be completed within the next two years. He said that other toll cables, some probably underground, will be completed in the state in case the company is financially able to carry on the work.

Copyright by International Film Service.
WIRING THE SCORE ON THE CAMP DEVENS RANGE.
Telegraph operators on the artillery range at Camp Devens, Mass., wiring the results to the officers in command of the batteries at practice.

Phrase "I'll Ring Again" Discontinued

Last December telephone operators in the Boston Metropolitan division stopped using the expression, "I'll ring again." This is made possible by the introduction of an ingenious device that makes a distinct ringing signal when you make a local call.

Calling a telephone number with the letter designation "W" and "M," the subscriber hears but one ringing signal. If subscribers having the letter designations "R" and "J," are called, two ringing signals are heard.

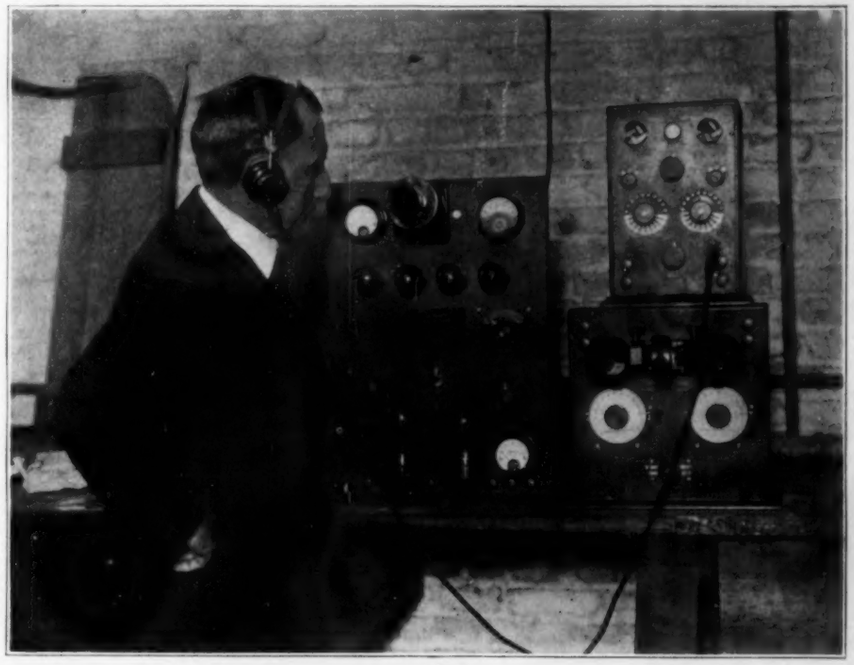
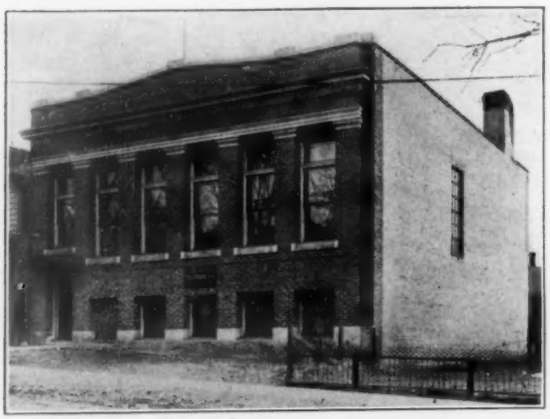


Photo from Underwood & Underwood.
Dr. Lee De Forest's Latest Invention, the Radiaphone, a Portable Wireless Telephone Designed for Use in Homes, Offices, Ranches etc., Operating Merely by Connection with an Ordinary Lamp Socket. (110 Volts). This Little Instrument has an Operating Radius of Almost 30 Miles. Sound Wave Adjusters Prevent Interference or "Listening In". The Outfit is Simple, Designed for Amateur Use, and Costs About $200.

Exchange Buildings of the Tri-State Telephone

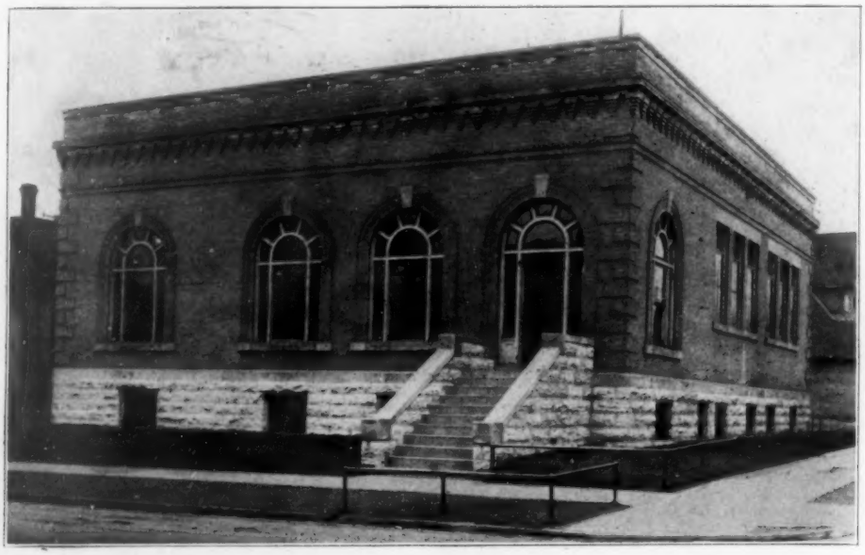
"Midway" Exchange of the Tri-State Telephone and Telegraph Company, St. Paul, Minnesota.

"Dale" and "Elkhurst" Exchange Building at the Right, Formerly the "Dale-Summitt" Exchange, St. Paul.

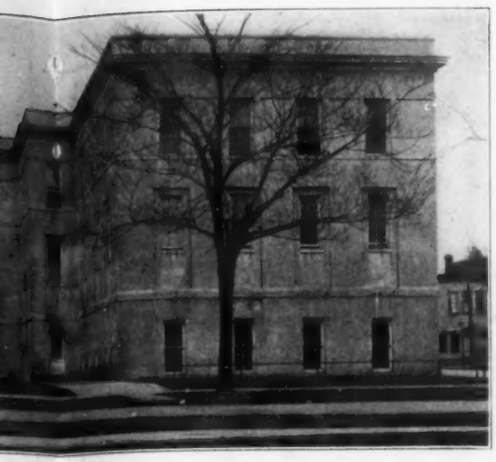


"Van Buren" Exchange, Automatic, Formerly "East" Exchange, St. Paul.

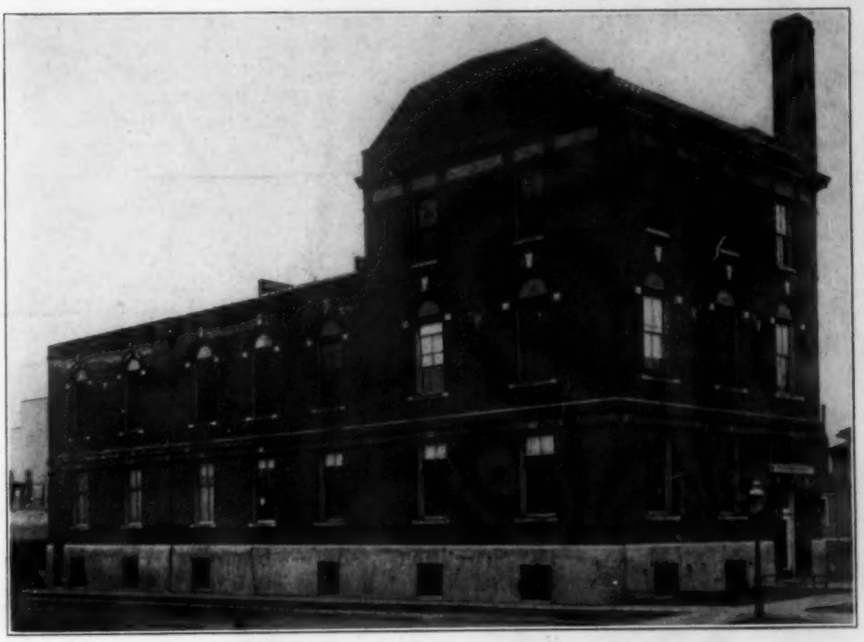
The New South St. Paul Exchange.



At Left, "Forest" Automatic Exchange, Formerly "Dale." At Right, Present General Office Building, Also "Park" Automatic Exchange and Toll Boards.



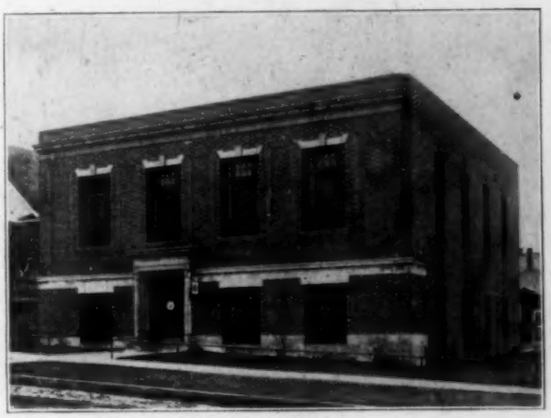
Below, in Center, Main Downtown Manual Exchange, Fifth and Cedar, St. Paul. Later to Become General Offices.



"Tower" Exchange, Formerly "Bomont," St. Paul.

and Telegraph Company

Tri-State Exchange at Winona, Minnesota.



"Riverview" Exchange, St. Paul, Formerly "Robie."

St. Paul Minnesota

At Right, "Garfield" Main Downtown Automatic Exchange, Eighth and Cedar, St. Paul. Formerly "Main" Exchange.

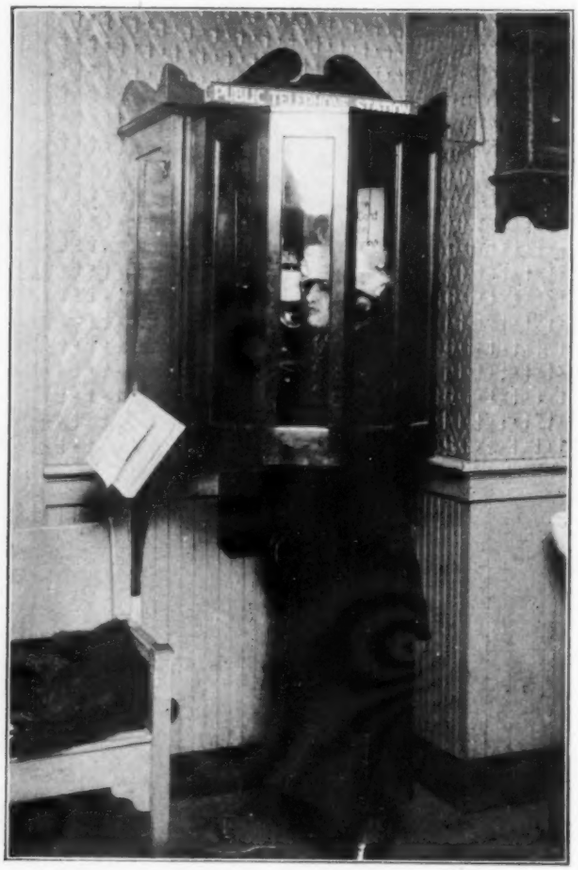
Bell Stock Sold at Par to Employees

A second opportunity is offered for employees to buy stock in the American Telephone and Telegraph Company.

This stock is sold to the employees at par, $100, per share, and is taken out of the salary of the purchaser. A rate of four per cent is all that is charged by the company for the use of their money for the purchase of stock, and the stock is now paying a dividend of eight per cent.

No employee is under any obligation to purchase stock and no manager is allowed to urge his subordinates to purchase it. No change in the future standing of the employee is affected by the purchase of stock. The company is simply offering its employees a chance to become stockholders in the company and reap the benefits therefrom.

A Simple Booth For Public Telephones That Keeps Its Users Comfortable and Yet Costs Less Than the Regular Form.



The crying need of telephone users of public telephones has been filled. A member of the New England Telephone & Telegraph Company, Manager John J. Barry, at Lynn, Mass., has conceived, developed, and improved the idea of a telephone booth that will overcome the trouble that patrons have experienced for years during the summer months, in finding the atmosphere of a telephone booth stiflingly hot.

Working in conjunction with Fred S. Messenger, of the Davis Wood Working Company, of Lynn, Manager Barry has built a disappearing telephone booth. It is now working with great success in the Boston, Revere Beach & Lynn Railroad Station at Lynn. "Disappearing booth" is, perhaps, not quite the right name, for, in reality, there is no booth. As a matter of fact, the booth only reaches to about the hips, and, on entering, you find the telephone right at hand and a sign which says "Draw cord on entering." By giving the cord a gentle pull, a circular glass door, working easily on three-point ball-bearings, encircles the user from behind, and shields one like any booth down to a trifle below the hips. The telephone conversation is as secret as in the usual style of booth. While one is using the telephone, the air circulates up from the floor to the roof.

When the call is ended, one pulls gently the cord at the left, where another sign reads "Draw cord when leaving." The booth—or, in reality, the front part of the booth—rolls around and disappears.

The new booth is just the thing in many places, because it does not require the space that the standard booth requires. When the booth is not in use, the glass enclosure rolls back and leaves the telephone and the interior exposed. All the dust and dirt that naturally congest on the floor of the present telephone booth are done away with.

The new booth means, then, good air, and is sanitary and clean at all times. Manager Barry has arranged for a few more to be made and placed in his territory. The inventive mind of Manager Barry is responsible for this booth, and although it is hardly probable that it will revolutionize the use of the present booth, it is, at least, a welcome addition to present equipment. The idea suggested itself to him during the war when there was a scarcity of materials, and naturally, being live and wide-awake, he sought for a way to get around the shortage of material. In perfecting this booth, he has accomplished his purpose, and no doubt the new booth will be greeted with enthusiasm in all sections.—New England Telephone Topics.

Directory Advertising Makes Rates Lower

The Reason Why Explained in "The Northwestern Bell"

By W. C. SMYTH

IF the telephone company should eliminate all advertising from its directories, what would the subscriber think of it and how would it affect him?

No doubt many subscribers would say it was a desirable move and others would say it did not affect them in any way.

But consideration of the reason for directory advertising will show that the elimination of the revenue now derived from directory advertising would have a direct effect on the price the telephone company must charge for service, and consequently on the subscriber's telephone bill.

The telephone directory is a necessary part of the furnishing of telephone service. The company must provide a list of subscribers and their telephone numbers in order to furnish satisfactory service. The cost of publishing this list is as much a part of the expense of furnishing service as the cost of the wires used or the operator's salary.

With advertisements or without advertisements, directories must be published at regular intervals.

The telephone company, to be sure, sells the advertising and collects the money, but the subscriber benefits when the directory is comfortably filled with advertising.

The telephone company's business is furnishing telephone service, and a definite amount of revenue is necessary in order to supply that service. Now if, through the sale of a by-product, directory advertising, the company is able to derive some of this revenue it follows that the amount which it is necessary to collect for its main product, telephone service, is directly reduced by just that much.

Hence it is evident that without telephone directory advertising it would be necessary to charge more for telephone service. And the subscriber, who pays all of the telephone company's expenses, would be directly affected.

The reason for telephone directory advertising from the standpoint of the advertiser, is of course the reason for all other advertising—because it pays. It does pay. The fact that 80 per cent of the advertisers in the telephone directories renew their advertisements from issue to issue is the strongest possible proof that it does.

Shrewd business men are not likely to invest money in advertising, time after time, unless it is paying them.

The telephone directory is referred to oftener than any other publication. It goes into the very best homes. And advertising space in it is cheap considering the life of the publication and the quality of its readers.

The salesman of directory advertising has something of real value to offer, space in a permanent publication which goes into the best homes and business houses of the community and stays there. Unlike most advertising mediums the telephone directory is never discarded or destroyed. While the issue is current it is preserved and referred to day after day and month after month.

Directory	Number of Stations	Revenue Fall Issue, 1918	Revenue Fall Issue, 1919
Des Moines	30,047	$989.00	$2,820.00
Davenport	12,708	566.00	1,479.00
Cedar Rapid	10,056	334.00	1,138.25
Dubuque	7,815	294.00	759.00
Ottumwa	4,909	95.00	427.00
Keokuk	2,852	70.00	259.50

The salesman of anything must believe in his product and its value before he can readily convince others that it is worth buying. This is true whether the commodity is typewriters or soap or advertising. For this reason we have made considerable effort to "sell" directory advertising to the man in the field, the commercial manager, who is responsible for the actual sale of space in his directories. If he believes directory advertising is a good buy he will have less difficulty in convincing the banker, the automobile dealer or the grocer that their advertisements in the directory will pay.

Directory advertising produces much business which is not directly traceable to the directory. Its effect is cumulative and the steady hammering of the advertisement repeated from issue to issue must eventually bring more and more customers.

An advertisement in the directory may or may not produce results from the first insertion. Few advertisements in any publication do, but the telephone user is bound to see and unconsciously read a merchant's advertisement in the directory many times during the life of an issue. Then sooner or later, when he needs furniture, groceries or a plumber, his mind will produce a familiar name associated with the commodity or service he wants.

He may not remember where he saw the name or why he remembered it, but the desired result is produced and a customer made.

The sale of directory advertising is logically a part of the job of the commercial manager and his force, but in our larger exchanges, where the advertising revenue is a considerable item and competition is keen, it becomes a specialty job, a job which requires a higher order of salesmanship—in fact a specialist in the sale of advertising—a specialist who knows the arguments from every angle.

During 1919 and the latter part of 1918 the plan of putting advertising salesmen on the job has been tried out in the larger Iowa exchanges with remarkable results. The comparisons printed on this page prove that the plan has paid. These do not include all the exchanges in which the plan was used but are representative examples of the result secured.

The use of special salesmen in the larger exchanges is but one phase of the active drive for more advertising revenue which has recently been carried on in Iowa with gratifying results. An educational campaign on the value of directory advertising has been effective. A study has been made of the value of directory advertising in the various exchanges with the result that many rates have been advanced. But in spite of higher rates for space the volume of advertising sold has substantially increased.

DIRECTORY PRINTING COSTS

The expense of furnishing directories is a real factor in the cost of furnishing telephone service. This year the directories of the North-

western Bell Group will cost approximately $165,000, but this gross expense will be reduced approximately $100,000 through the sale of advertising in the directories. This will be an increase in round numbers of $25,000 or 33⅓ per cent over the revenue derived in 1918.

It is the aim to make all directories revenue-producing or at least self-sustaining.

In determining what to charge for space in a directory it is not practical to fix the rates arbitrarily according to the number of stations in the exchange or the population of the town, but all the following factors are taken into consideration:

Number of stations.
Size of town.
Character of business houses.
Rates at which advertising is successfully sold in other advertising media.

If conditions were the same in all towns of the same size, of course the fixing of rates would be simply a matter of determining standard advertising rates according to the number of stations and the population of the town.

As it is, however, towns of equal size may be entirely different in make-up—one town may be a thriving manufacturing town, the other mainly a residence town with few business enterprises of importance. It is not difficult to understand why advertising may be sold at a higher rate in the first town.

The directory as an advertising medium is not comparable in many ways to other advertising mediums; it does not entertain and it does not instruct. But what interests the advertiser is the number of prospective purchasers who will see his advertisement. And the directory is "the most used and most useful" advertising medium in any locality.

Census Report on the Telephone Industry

According to the report about to be issued by the Bureau of the Census showing the results of the census of telephones covering the year 1917, there are 53,234 separate telephone systems and lines. These lines and systems operated 28,827,188 miles of wire in the United States—enough to girdle the earth at the equator 1,153 times—and connected 11,716,520 telephones and 21,175 public exchanges. The messages or "talks" sent over these wires aggregated the stupendous total of nearly 22,000,000,000, or, to be exact, 21,845,722,335. Figured on the estimated population of the country in 1917 this gives 211 messages per annum to every man, woman and child.

The industry in 1917 gave employment to 262,629 persons, of whom 171,119, or over 65 per cent, were women. The sum paid out in salaries and wages amounted to $175,670,449. These employees operated plants and equipment valued at $1,492,329,015, which yielded operating and non-operating revenues of $391,499,531.

The report discusses the development of the telephone industry, telephone equipment and traffic; offers interesting comparisons between the Bell and other systems, and between the telephone system as a whole and the telegraph system, and gives important financial statistics of the industry. Detailed figures are presented for 1917 by states and geographic divisions and comparative statistics for earlier years. The statistics for 1917 are believed to be more accurate than for any previous census due to the uniform system of accounts provided for telephone companies by the Interstate Commerce Commission, which has been in use since January 1, 1913.

The Bell telephone system controlled over four-fifths of the total wire mileage, employed over three-fourths of the employees of the industry, paid over four-fifths of the total bill for salaries and wages, and received nearly four-fifths of the total revenue.

Over three-fifths of all the telephones in the United States bore the "Bell" sign, and two-thirds of all persons who were "wanted on the wire" were wanted on a Bell wire. The dominating part that the Bell system plays in the industry may be further illustrated by the fact that of all the other systems reported, 96.1 per cent reported annual incomes of *less* than $5,000.

Comparisons with previous censuses bring out in a striking way the remarkable development of the industry. During the decade 1907-1917 wire mileage increased 129 per cent, the number of telephones 102.8 per cent, the number of messages 90.5 per cent, for systems having incomes of $5,000 or more.

A comparison by geographic divisions brings out the fact that considerably more than one-half of the telephone systems reporting annual incomes of $5,000 or more in 1917 were located in the Middle West, while systems and lines reporting incomes of less than $5,000 were found in the largest numbers in the western states of the central groups.

The financial statistics of the report show that while the revenue of the telephone companies has more than doubled during the decade, 1907-1917, the expenses have increased at an even more rapid rate. Much of the increase in expenses was due to increase in salaries and wages paid. These had advanced from 47.4 per cent of the total expenses in 1912, to 54.2 per cent in 1917. For systems reporting annual incomes of more than $5,000 in 1917, the average total revenue per telephone was $38.41, average net income per telephone $6.13, and average surplus per telephone $1.46.

This report of the telephone industry is part of the "Census of Electrical Industries" which was taken in 1918, covering the operations of the fiscal year 1917.

The first census of the telephone industry was taken in connection with the decennial census in 1880, only two years after the first public telephone exchange was opened for business at New Haven, Conn., on January 25, 1878. In 1890 a census of telephones was again taken with the regular decennial census, but for 1902 and for every fifth year since a census of Electrical Industries, which includes telephones, has been taken. The development of the industry, therefore, is shown from its infancy.

Use Telephone Wires for Clothes Lines

"The Toonerville Trolley" has nothing on a Perry County, Ky., rural telephone company, which unfolded some of the unique difficulties under which public service corporations labor in its report to the State Auditor to prove that it has no franchise value.

"It's only five miles long," the president explained, "but we noticed that the service was unusually bad and, upon investigation, discovered that the women of the neighborhood were cutting the wires to make clothes lines." He didn't blame them, for the wires were strung on trees, fences and bushes and didn't look as if they belonged to a telephone system.

British Aircraft Telephony

Abstract of the Paper Read Before the Institution of Post Office Electrical Engineers

By Capt. B. S. COHEN

WORK on aircraft telephones was originally undertaken at the request of the British Admiralty at the end of 1916 to meet requirements of the Royal Naval Air Service, and as a result of extensive research in the post office laboratories and in the air, telephone apparatus

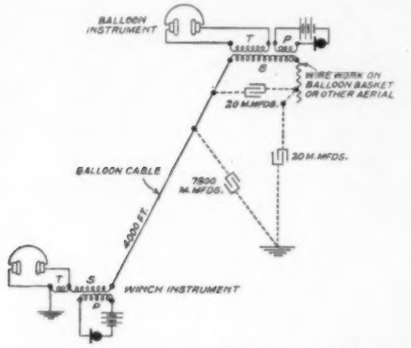


Fig. 1.—Kite Balloon Telephone, Theoretical Diagram. Single-wire Working.

was designed for use in kite balloons, airships and heavier-than-air aircraft.

The kite balloon observer has to be in continuous communication with the ground or ship's deck, as the case may be, at any height between several hundred feet and 4,000 feet and at first it was essential to obtain communication for naval balloons over the balloon cable without a metallic return circuit. The main difficulty with a telephone core in the balloon cable is due to the fact that the latter has to withstand a normal pull of 1 to 2 tons and is wound up or released at speeds up to 250 feet per minute, with the result that the earlier telephone cores either broke if the conductors were at all tight or if slack the conductors were forced by the pressure when winding through the insulation and short circuited on the steel strands of the balloon cable.

These difficulties have been overcome to a great extent, but it has always been found advisable to use a telephone capable of operating either over a metallic circuit or through the balloon cable, with a return circuit consisting of the capacity of the balloon basket to earth. This condition, of course, necessitates insulating the winch from the ground or ship's deck. Fig. 1 shows the electrical conditions to be met with in kite balloons flying at 4,000 feet. The capacity of the balloon basket to earth at that height is about 20 m.mfds. and this capacity is shunted by the much larger capacity of the balloon cable to earth, which is of the order of 7,500 m.mfds. The treminal impedances of the two ends of the circuit are very different being of the order of 10,000,000 ohms at the balloon end and 30,000 ohms at the ground end, and in consequence it was found advisable to design different instruments for use at the two ends.

Fig. 2 is the diagram of the connections used, the principle adopted being to employ a triple wound transformer with a low resistance, 300 turn primary joined to microphone and battery; a very high impedance secondary of 35,000 turns joined to line and a tertiary of 2,000 turns connected to the double head receiver. The step down to the receiver enables

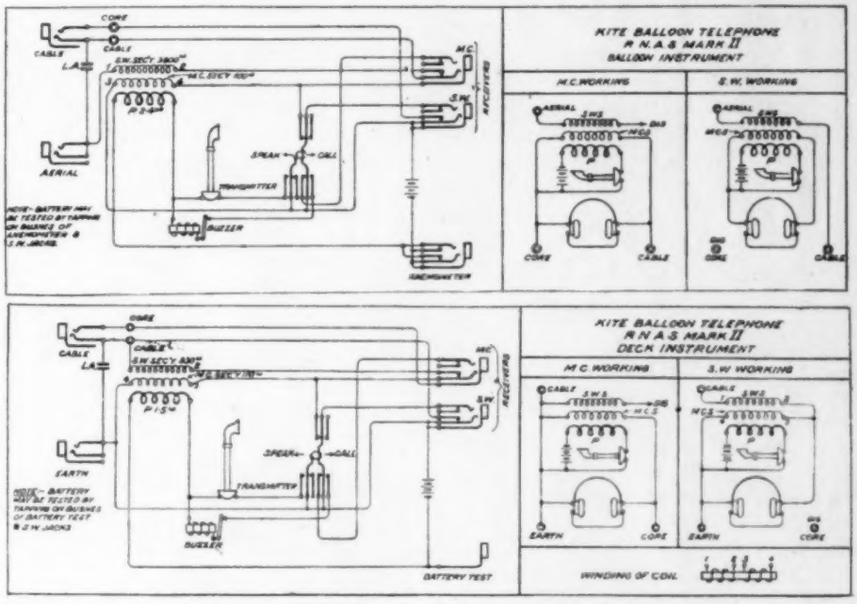


Fig. 2.—Diagram of Connections Used on Kite Balloons.

ordinary low impedance receivers (150 ohms windings) to be used. These figures are for the balloon instrument transformer. The transformer at the winch end has similar primary and tertiary windings but has a secondary of only 13,000 turns to suit the lower terminal impedance at the ground end. When operating on metallic circuits the secondary is disconnected and the tertiary takes its place; the change is effected by a plug and jacks.

The transmitter used is an inset and a speaking tube mouthpiece is supplied, which, however, need not be used for metallic circuit working as ordinary speech anywhere in the basket is picked up and transmitted efficiently to the ground. When working single wire the speech efficiency is approximately equivalent to standard talk over 35 miles of standard cable. The transmitter is operated by three dry cells embodied in the instruments. A lightning arrester, carbon block type, is included as the balloon cable is frequently highly charged during windy weather and sparks of ½ inch or more can be continuously drawn from it. A combined ringing and listening key is fitted which closes the transmitter circuit in the retaining position and operates a 2-ohm buzzer in the non-retaining position. A safety device is fitted so that the instruments cannot be packed away in their transport cases with the battery circuit closed. The equipment is completed in the case of the balloon instrument by an anemometer jack,

which is used to connect a make-and-break operated by an anemometer fan to the balloon cable, so that wind velocity at any height can be read off electrically on the ground. Some thousands of these instruments were in use throughout the war.

On an airship the standard telephone equipment includes the switchboard which is fitted in the navigating cabin and is operated by the navigating officer. This comprises drum indicator calling signals and combined ringing and listening keys. The out-stations include a 10-ohm howling receiver, a gas-tight switch-hook, a transmitter and pair of receivers. The system of operation is common battery and triple conductor line cable is used. The closing of the hand microphone switch at the out-station actuates the drum calling signal (which is painted with radium paint) and this closes a buzzer circuit and operates a 10-ohm howler. The depression of the ringing key on the control board also closes the buzzer circuit and actuates the howler at the out-station. The removal of the microphone from the switch-hook replaces the howler by a pair of headgear receivers, which, being wound to a high resistance, prevent the buzzer from operating if the key should be held depressed.

The transmitter is mounted behind felt damping pads and an ebonite grid in a leather-covered box with a pneumatic edging to fit the mouth. A handle with switch is provided and is rendered gas-tight by a rubber cover. This form of transmitter, together with the double headgear receivers, is now being replaced by hand combination sets with throat microphones insensible to air-borne sounds. The control board is rendered gas-tight by covering the key fronts with rubber and completely enclosing the back of the key and indicator boards. The buzzer is also completely enclosed and a glass tube fuse G. P. O. pattern is used for protective purposes. The control board is mounted on anti-vibration rubber suspensions.

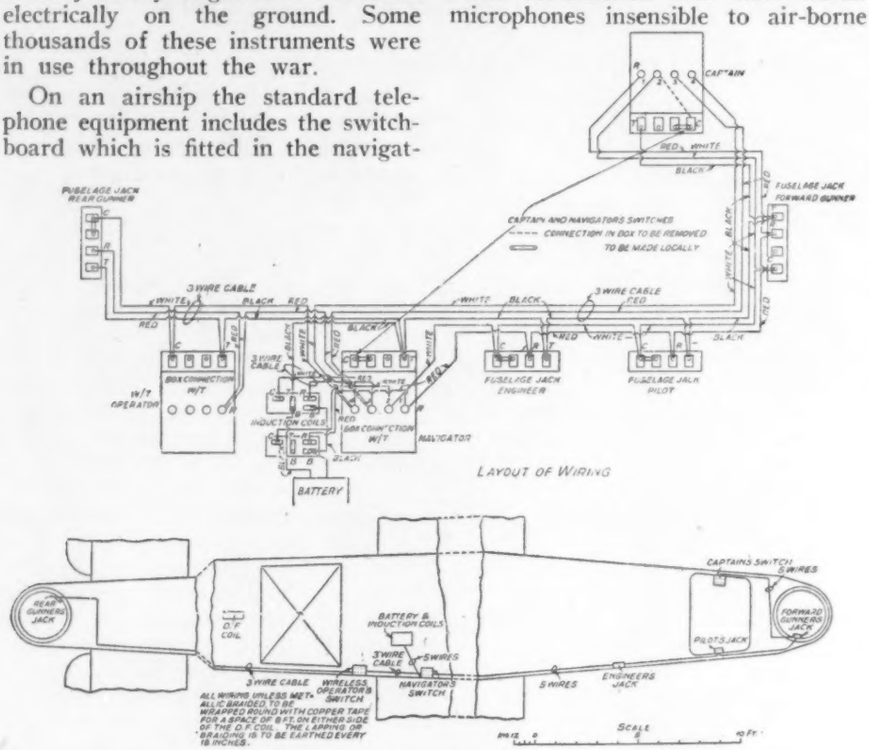


Fig. 4.—Diagram of Inter-Communication Telephone System on "V" Type Handley-Page.

The system is designed to work off a 12-volt supply, which is the standard lighting voltage on the ship. It has, however, recently been found advisable to fit a separate telephone battery of 5 to 10 ampere hours capacity. The gas-tight switch-hook is an ingenious device designed by Capt. Toulmin Smith, and consists of a flat piece of bakelite operated by the switch-hook and sliding over three contacts in a barrel filled with mercury, the flat piece of bakelite merely squeezes the mercury away from the pair of contacts covered by it and thus disconnects them from each other. A suitable quad wire cable as regards weight and conductivity can now be dispensed with and involves no increase of weight in the installation.

The noisiest positions in an airship are, of course, in the engine gondolas, where the engineer may be in very close proximity to a pair of the largest type of aero engines with a total output of nearly 1,000 h. p. running all out. In such cases the howl of the 10-ohm howling receiver will be inaudible and a high power Klaxon type horn is required as an audible howler is replaced by a single make relay in a gas-tight case and this closes a local circuit through the Klaxon horn, and the 12-volt lighting mains and also operates a switch board lamp as a visual signal.

In connection with the development of aircraft telephones it has been found necessary to make a careful study of the nature of aircraft noises, and this has been done with the aid of the oscillograph and by other methods. From the point of view of intercommunication, engine exhaust is by far the most serious and accounts for between 70 and 80 per cent of the interferences, although, strangely enough, the silencing of the exhaust does not much affect the distance at which a machine is audible to a listener on the ground.

The final form of microphone designed for this purpose includes a novel feature in the method of transmitting the vibrations to the transmitter button. A mushroom-shaped piece of insulating material transmits the vibrations of the area on which it rests to the center of the transmitter diaphragm and then to the microphone button. By the use of this device the damping action of the flesh when resting on the periphery of the diaphragm is done away with and all the vibrations are taken to the most efficient point on the diaphragm. The button, which can be of any good type, is insulated from the case of the transmitter. The diaphragm is of soft brass and is drawn in one piece with the case and planished; its thickness is 32 mils and diameter $1\frac{3}{16}$ inches. The best position for use is in the hollows on either side of the wind-pipe, and good results can be obtained over a fairly wide area of this part of the throat. The pressure should be only just enough to maintain the microphone steadily against the throat when the latter is in vibration.

When the microphone is used in conjunction with head receivers it can be mounted either in a necklet, made of twill and chamois leather, or fixed in a handle with a press switch. The microphone can also be mounted

in combination with a receiver, and as an all-round instrument this form is finding favor for use on large aeroplanes and in airships. The articulation, whilst not so good as that of a good mouth-operated transmitter, is quite clear and distinct, and long lists of isolated words can be transmitted with very small percentage error. The instrument is practically unaffected by extraneous noises of large volumes, even when these are some thousands of times the volume of the transmitted speech, as in the case of high-powered unsilenced aero engines. The insensitivity of the throat microphone to extraneous noises renders it possible for use in any noisy situations other than on aircraft, as for example, in shipbuilding yards, stamping mills, etc. This transmitter is being manufactured by the Relay Automatic Telephone Company, which has rendered great assistance in its development.

The Admiralty are alive to the possibilities of the throat telephone as a ship's telephone, and experiments have been in hand for some time on H.M.S. "Vernon" and on battleships. I understand the results, so far as they have gone, have been satisfactory and that the general adoption of this instrument is in contemplation.

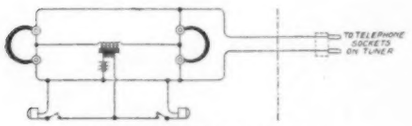
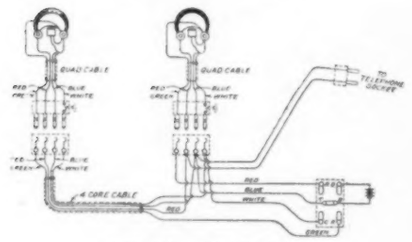


Diagram Showing Circuit.



WIRING DIAGRAM.

Fig. 5.—Diagram of Combined Wireless and Telephone Set.

The inter-communication telephone sets have been designed to allow the head receivers to be used either for wireless telegraphy or telephony, and a receiver of 2,000 ohms resistance designed for wireless telephony was adopted. This receiver is used mounted with the microphone as a hand combination or a pair are mounted in a flying-cap for use independently. The efficiency of the aircraft telephone depends to a very great extent on the design of the head gear, and many patterns were designed and rejected before a generally suitable form was obtained. A complete headgear set includes flying cap, receiver and microphone in necklet, etc. The receiver can be either loose in the cap-ear pockets and pressed up to the ear by the straps or enclosed in spongy rubber ear-cups, which take some of the direct pressure off the edges of the ear and also absorb perspiration. The disadvantage of the rubber ear-cup is bulkiness, rendering the wind pressure on the ear pocket rather noticeable.

When the hand combination set is used, it is merely necessary to cut a hole in the side of an ordinary pocketless flying cap over the ear and the receiver is placed over this hole, which is normally covered by a flap.

As regards switchgear, plugs and jacks of the familiar four-prong and hole telephone pattern have been adapted. In a special set designed for use with wireless telephony the plugs and jacks are rendered irreversible by replacing one plug-prong by a prong of larger diameter and drilling out the corresponding hole in the ebonite socket. All jacks and plugs are rendered weather-proof by use of rubber covers, and the cords have a waterproof lapping. A switching-box for connecting up various services is used, which can be arranged to connect up either inter-communication, wireless telegraphy, wireless telephony or direction-finding wireless gear to the same head receivers. The connections of a set of this kind are shown in Fig. 3. The pair of receivers at each station are all in parallel for intercommunication (the individual receivers of a pair are in series) across the 400 ohms secondary winding of induction coil, and all microphones are brought on to the common 1-ohm primary through a 6-volt accumulator battery. The telephone installation on a large long-distance bomber, such as the V-type Handley-Page under war conditions, is quite elaborate. (See Fig. 4.)

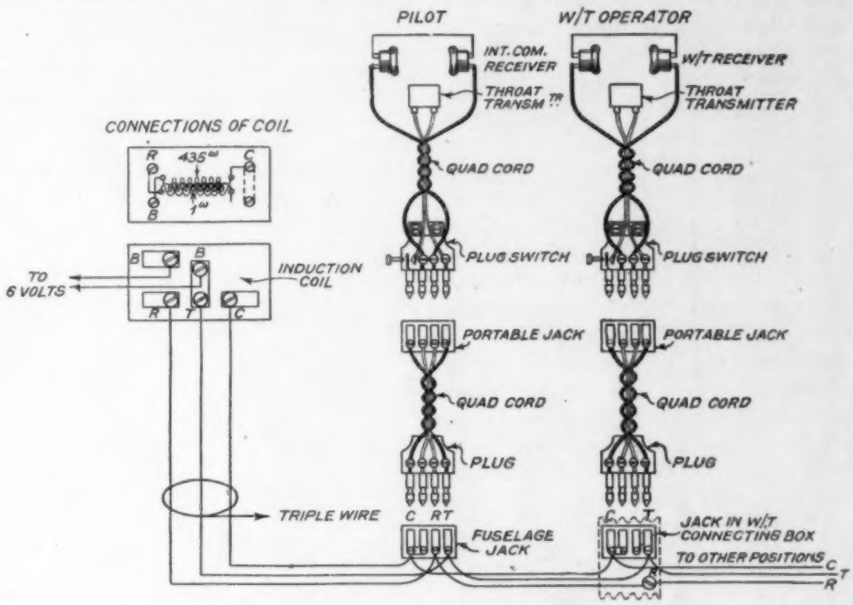


Fig. 3.—Diagram of Connections of Aircraft Inter-Communication.

A visual calling-up signal is required when using hand combination sets. One form used consists of a push in which the button is replaced by a pea lamp. These little lamps are very strong and capable of withstanding a great deal of hard usage and vibration. It may be of interest to note that even aircraft telephones are not immune from cross talk, and in order to prevent interferences with direction finding and other forms of wireless and also disturbances from the engine magneto, it is found desirable to cover the line wiring with copper braiding and bound to earth, *i. e.*, aeroplane fuselage strap, at 18-inch intervals. On a V-type Handley-Page there are four engines with a total of 16 magnetos, so that magneto disturbance becomes a factor to be dealt with. An interesting extension of the use of intercommunication telephones on naval aircraft may be mentioned. The machines which fly from the deck of the large aeroplane carrier H. M. S. "Furious" have a

jack in the tail connected to the intercommunication telephones, and this is connected by a plug to the ship's telephones, and the navigating officer can thus communicate with the air pilot until he actually takes off, when the plug is pulled free by the motion of the plane.

The special problems to be met at high altitudes are numerous. At a height of 15,000 feet upwards there is a noticeable decrease in the volume of air-borne sounds, and it is also necessary for the occupants of the machine to take oxygen. In some cases a mask is worn into which oxygen is fed, or alternatively the oxygen can be taken in frequent whiffs through a mouthpiece. The throat microphone is independent of atmospheric density and operates quite as well as high as at low altitudes. If the necklet pattern is in use it is, however, found advisable to wear this very loose. The behavior of accumulators at the low temperatures met with at high altitudes has been investigated and it is found that the capacity of a cell is reduced to 57 per cent of its normal capacity at a temperature of 13°C., and this is about the normal temperature at an altitude of 23,000 feet. The difficulty is met by placing the accumulators in lagged wooden boxes, and the duration of time at which the machines remain at high altitudes is then insufficient to freeze the accumulators.

In connection with the development of wireless telephony it was found necessary to equip two-seater machines so that wireless and intercommunication telephony could be continuously connected up without the necessity of switching the head receiver from one service to the other, and difficulty was found in devising a suitable circuit which did not reduce the wireless range. A circuit was devised which fulfilled these conditions by simple means. Fig. 5 illustrates this. The double head receivers at the two positions have the inter-communication induction coil secondary bridged between the central points of the individual pairs. Wireless telephony is in consequence unaffected by the presence of the coil. The introduction of this system necessitated the use of quad wiring and of irreversible plugs and jacks. The advantages, however, outweighed these disadvantages, and this arrangement was adopted as standard in connection with wireless telephony working.

Operators Get Married by Hundreds

Cupid is playing havoc among the New York telephone girls, and that is one reason why subscribers are waiting for numbers, according to testimony given at the investigation into the telephone service by Public Service Commissioner Theodore L. Fennell. Chief operators and telephone company officials agreed that marriage was one of the leading causes of desertion from the switchboard ranks.

T. P. Sylvan, assistant to the president of the New York Telephone Company, offered figures showing that 856 girls had abandoned telephoning for matrimony in 1919, as against 447 in 1918.

In regard to new recruits, Mr. Sylvan said that "there was the greatest possible competition for female help in the city," and that the holiday season found "the market swept." Employers had told him, he added, that they paid any price a girl asked to get her services for the Christmas holidays.

Electron Tube Generators Subject of Booklet

"The Determination of the Output Characteristics of Electron Tube Generators," is the title of Scientific Paper No. 355 of the Bureau of Standards.

Owing to saturation and rectification effects in three-electrode vacuum tubes, the currents which they deliver to any type of output circuit, when used as a generator, are heavily loaded with harmonics. Experimental results indicate that the frequency of the oscillating currents generated is the natural frequency of the output circuit. Hence this circuit behaves as a filter in series with the tube and the D. C. power system, and the useful output current is approximately sinusoidal, whatever the distortion of the tube currents, depending in amplitude solely upon the fundamental constituents of the tube currents. General expressions are derived for the power and current output in terms of static characteristics of the generating tube, and are corroborated by experimental results obtained with a particular tube.

This paper is now ready for distribution and any one interested may obtain a copy by addressing a request to the bureau.

OUR EXPANDING FOREIGN TRADE—BILLIONS IN EXPORTS—GLIMPSES OF PEOPLE WHO ARE HANDLING OUR GOODS IN FOREIGN LANDS.

Telephone cables, manufactured by the Western Electric Company, in a trench in a street in Changsha, China. Many Chinese cities have installed telephone systems with American equipment, and hundreds of other Chinese cities will put in telephone systems in the next few years. The conservative Chinaman is rather slow in adopting Western ideas, but he is finding the telephone to be indispensable.

(*Concluded from Page* 18)
to develop along the lines for which we are best suited and can therefore make the greatest progress.

This all necessarily means the greatest contentment and productivity, there is no question about it; we have actually seen it in the past. Let's, therefore, do our everlasting best to keep in active operation these good fundamentals of which we have been talking; for, under such conditions, we *must* have an efficient department, and honest service *must* win proper rewards.

Enormous Expenditure for Michigan

Believing that Detroit and Michigan are entering an era of prosperity and industrial advancement hitherto undreamed of, the Michigan State Telephone Company contemplates the necessity during the next few years of an expenditure of $36,000,000 in preparing for a business expansion of city and state which, it believes, will astound the world.

It is expected that $12,000,000 of this sum will be spent by the company during 1920, Detroit's share in the year's program being approximately $6,000,000.

Not alone extension, but improvement of service is on the books, according to G. M. Welch, general manager, who made the announcement. The Michigan State Telephone Company, he says, realizes that industrial expansion of the city and state is greatly dependent upon wire facilities, particularly the ability and capacity of the telephone systems to handle volume traffic.

Expenditure immediately of $12,000,000 is necessary, Mr. Welch explains, because expansion of the service was held back by the war which took both men and material, on top of which came the most rapid development in industry and population that Detroit, Flint, Pontiac and other cities of the state have ever experienced.

In Detroit alone it is declared that 2,000 men are each week added to the payrolls of industry, resulting from the springing up of new industries, opening of new plants and growth of long established businesses, and meaning the building of thousands of homes and many business blocks. In turn these create need for extended telephone facilities.

The Michigan State Telephone Company has estimated conservatively, that before 1936 Detroit will have attained a population of 2,250,000.

Much of the $12,000,000 to be paid out during 1920 will be spent in fundamental plant construction and to meet the needs of the future industry and population of Detroit—that already in sight. Gigantic extension of conduits, building construction and great extension of wire systems must be entered into to meet the sort of future the company sees for the city.

The plans for Detroit's $6,000,000 telephone system expansion next year show that most of this sum will be spent for conduits, outside cables and poles and switchboards and construction. Switchboards alone will take $1,000,000, telephone sets and private switchboards another $2,000,000.

In cities outside of Detroit, $4,000,000 will be spent. For toll lines and additional circuits and to improve the service and relieve the present overload $2,000,000 will be expended. Included in these figures is the sum of $1,900,000 for miscellaneous items of plant equipment to help bring about service improvement.

Twelve million dollars a year the next few years is the outlay contemplated by the company's engineers if present growth continues.

Toll line extension is one of the big items included in the 1920 program, and contemplates cables from Detroit to Toledo and from Detroit to Inkster, four miles west of Dearborn, as well as completion of the cable north to Birmingham which has already gone as far as the Eight-Mile road. These improvements will mean the removing of all the Michigan State Telephone Company's open wires in the vicinity of Detroit, and the company hopes that the next hurricane will find conditions such that it will be unable to knock out almost the entire toll system as well as much of the other service.

What the telephone people have in mind is a storm-proof telephone system that will be on the job, no matter what happens.

Required for the 1920 program are astonishing amounts of equipment and material. A great deal of the raw material will come from Michigan.

The engineers estimate that 2,513,900 pounds of copper wire will be required; 1,054,000,000 conductor feet of copper wire and 40,000,000 feet of twisted pair insulated wire.

Of steel strand for anchoring the estimates call for 2,264,000 feet and 192,000 pounds of galvanized iron wire will be strung. Michigan will also supply 37,000 cedar poles which, extended end to end, would make a staff 213 miles in height. More than 60,000 cross-arms will be used on these poles.

Of lead, 7,000,000 pounds will go into the cables. Of clay conduit 1,314,829 duct feet will be laid during 1920, meaning the opening up of about 220,000 feet or 42 miles of street trenches.

The 1920 budget also calls for 58,000 new telephone sets, 598 single and 34 multiple position private branch exchanges and 103 toll and service observing stations, besides 66 common battery subscriber switchboard sections for exchanges and many magneto switchboards.

With the money available and the plans in shape, the only difficulty the Michigan State Telephone Company will face in carrying out the program outlined is in getting the necessary material, equipment and labor. The engineering work is already under way and equipment orders are being placed.

For 1920 there will be required 1,000 more operating employes and approximately the same number of construction employes to carry on the year's work. The company, at present, has on its payroll nearly 8,000 persons.

Eternal Vigilance the Price of Service

We all know good plant maintenance protects our service, good service protects our employes and good employes protect our company from public criticism. Therefore, says R. Spillman in the *Southern Telephone News,* we should protect our company by our daily efforts to reduce and prevent plant troubles.

It is our duty to our company to specialize in pleasing the public at this particular time, as our organization has been depleted by the war; therefore, our experienced employes should put forth extra productive efforts until our inexperienced employes have become thoroughly efficient.

We can best please the public by rendering them as nearly an uninterrupted service as is possible, and to do this our plants must be maintained at the proper standard. With this in mind it will be well for us to endeavor to improve the plant conditions

wherever necessary and as economically as possible.

In addition to the general inspections of buildings, subway, pole lines, cables, terminals, cut-ins, subscribers' station wiring and equipment, it is also important to make periodically an exhaustive investigation and examination of our plant.

To handle properly an inspection of this kind in an exchange, the work must be done by some one of experience and in a systematic manner.

All complaints which are received from the traffic department on Form No. 505 should be properly entered on the card record Form No. 293, and the report of the result of the test or the trouble found should also be entered on the card.

It is important that these records be carefully kept, as they are our barometer of troubles, and an inspection of these records will quickly reveal plant conditions.

With a correct cable record Form No. 517 and subscribers' station card record Form No. 293 it is not difficult to start such an inspection; therefore, all employes in charge of these records should keep them properly posted and corrected.

A routine inspection will locate the weak parts of the plant, and if handled through to completion and the proper repairs made it will reduce the repeated troubles due to defective conditions.

As an inspection of this kind should be started and completed in a systematic manner I have arranged the following instructions as a guide for the employe to use while engaged in such work:

1. Refer to the cable record book, Form No. 517, and begin checking with cable No. 1, or the lowest numbered cable in the exchange, and check each circuit number connected to this cable to see that the cable record agrees with the information shown on the card record, Form No. 293. If errors are found, correct them. As each card is checked remove it from the card filing case.

2. Inspect all the card record Forms No. 293 for the circuits connected to this cable, and those which indicate an inspection is necessary to reduce the number of repeated troubles due to defective plant conditions should be held, and the others replaced in the file.

3. Group these cards for the separate terminals to which the circuits are connected.

4. Prepare a list showing all these terminals, their block number, location and pair assignments in the cable. The terminals should be arranged on this list so the first terminal listed will be a terminal near the exchange in location, and the others listed in sequence so the last one listed will be the one farthest away from the exchange. The individual cable record maps, the city aerial construction or underground construction maps may be used for reference in compiling this list.

5. The neutral conductor in low-cuit number, cable pair numbers, names and addresses of the cut-ins and stations to be inspected, also the nature of the repeated troubles, in order to have the proper information as to the cause of the troubles while making the inspection.

6. With this information the employe assigned to this work should begin with the first terminal on the list and inspect all the circuits which have verified the formulas and conspect to improve plant conditions.

7. In connection with these circuit inspections the employe should also make a general inspection of all outside and subscribers' station plant connected to each cable, also the cable and cable terminals and report all defective conditions found which need attention and repairs in order that the plant may be properly maintained and other repeated troubles prevented.

8. While making these inspections work orders on Form No. 936 should be prepared for each specific repair detail which is found to be necessary. These work orders should also show the cable number, provided the work is on the cable or circuits connected to it.

9. After inspection is completed for each cable all of the work orders should be carefully edited by the district, plant chief, who will, if necessary, make personal inspection to determine whether the repair work proposed is justifiable according to the plant condition, also to determine if the proper results will be obtained in the performance of the work.

10. The work orders should be promptly worked by the regular employes assigned to maintenance work, or other authorized employes.

11. In making these inspections and repairs, estimate work in progress or proposed estimate work to be shortly executed should be carefully considered so that no maintenance work will be imporperly planned or performed.

12. Each cable in the exchange should be systematically covered in this manner and a correct record kept of the dates when each cable was inspected and other details, in order that the representatives from the division office may properly supervise the maintenance work in each district and exchange.

Bureau of Standards Paper on Radio Aerials

A new publication of the Bureau of Standards, Scientific Paper No. 354, is entitled "Principles of Radio Transmission and Reception with Antenna and Coil Aerials."

The functioning of the two principal types of radio aerials is worked out quantitatively from fundamental electro-magnetic theory. Experiments have verified the formulas and conclusions presented. Formulas for the current received in either antenna or coil aerial in terms of current in either type or transmitting aerial are given, as well as comparison formulas giving the relative performance of antenna and coil aerials under various conditions. The advantages of the condenser type of aerial are presented. The theory and nature of radiation are discussed, and applied to the elucidation of some current fallacies. The basic principles of design of aerials are given. Desirable lines of future research are pointed out. The use of the coil aerial as a direction finder, interference preventer, reducer of strays, and submarine aerial are not among the subjects treated.

This paper is now ready for distribution, and any one interested may obtain a copy by addressing a request to the bureau.

The Iceland Telegraph and Telephone system at the end of 1918 comprised 2,256 km. (pole route) and 6,692 km. (length of wires). There were 140 stations, 1,877 telephone instruments and 12 telegraph instruments, the telegraphic work being largely dealt with by telephone. There were 752 subscribers in Revkjavik, 139 in Akureyri and 79 in Vestmannaeyjar.

Telephone communication between the German Rhenish Province and France has been reopened. The new direct telephone service between Germany and Sweden, 625 miles, including 87 under sea, was successfully inaugurated on December 1st.

European Telephone Practice

Translations from the Foreign Press and Communications from European Engineers

By FRED W. SCHOLZ

Danger from High Tension Lines and Protective Measures

THE development of long distance transmission of electrical energy and the consequent employment of high tension currents has resulted in the frequent parallel running of high-tension with low-tension lines, as are used for telephone and telegraph work, and has made the work of the repairman and the lineman doubly dangerous and risky. It is quite natural, therefore, that a great deal of attention has been paid in the last few years to the protection of life from the deadly high-tension currents, and the present article is a contribution to the literature along the same lines.

The phenomena accompanying the use of high-tension lines of great capacity have resulted in the development of equipment which is destined primarily for the protection of the users of the lines and the men whose duty it is to inspect the condition of the system and make the necessary repairs. In order to avoid any confusion it may be stated at this point that only such protective devices will be discussed here which may be included under the term protective groundings, and which are made for no other purpose than to protect human life and are not at all necessary for the operation of the electric system as such.

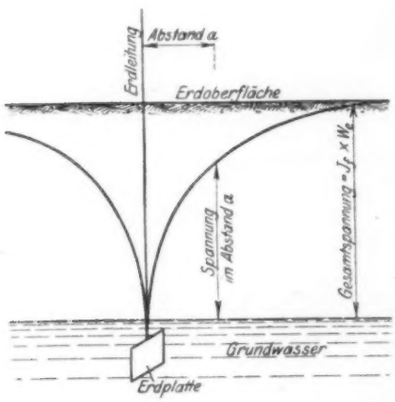


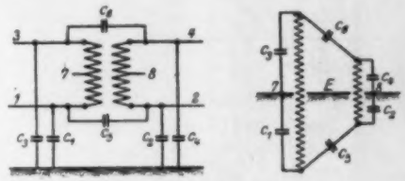
Fig. 1. Distribution of Voltage in the Vicinity of the Ground Plate.

Such, for example, is the connection between the rails of an electric railway and the surrounding ground, whose only purpose is to prevent tension or voltage of any degree between the earth and the rails. As a matter of fact, the electric railway is just as well able to operate, even if the rails are insulated from the ground and if the potential between them differs. On the other hand, the ground plates of lightning arresters and those of single-pole telegraph lines must be considered as groundings necessary for operation, as these lines could not operate without the ground connections made by these devices. It is necessary to keep this distinction, between grounded connections for protective reasons and those for operating reasons, well in mind in reading this article.

Protective ground connections are designed to protect life, in the first place, of course, human beings, against the dangers of high-tension lines. The use of such groundings rests primarily on the assumption that man is always "grounded," or in other words, that man always possesses the potential of earth. If this is true, then all that is needed is to bring the other body to the same potential, "ground" it in other words, in order to make contact between this body and man harmless. The words "to ground similarly" unfortunately are not true to conditions, however, and the assumption that man is always "grounded" is also not universally true.

If we may be permitted to use a paradox, we might say: "Every good ground connection is unnecessary, and every necessary ground connection is poor"—for the truth of this becomes apparent, when we remember that every good grounding immediately becomes poor and insufficient as soon as a transmission of current due to the inevitable resistance causes voltages in the vicinity, whose maximum value corresponds to the product of both factors. What form the voltage takes in the vicinity of the ground plate is shown in Fig. 1.

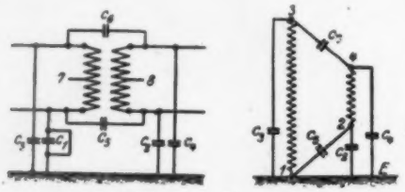
On the way from the conductor to earth the electric current usually finds three series-connected resistances; first, the resistance of the metallic conductor, which usually can be entirely neglected; second, the intermediate resistance between metal and earth, and third, the expanding resistance in the earth itself. As the latter is proportional to the current density, and as this is greatest in the immediate vicinity of the metallic ground connection, this resistance almost coincides in the matter of space with the intermediate resistance and can be added to this latter. The farther away from the electrode, the lower is the voltage between two equidistant points in the direction of the paths of the current conductors. Fig. 1 was obtained by connecting a sensitive voltmeter with one pole to the electrode, with the other pole a thin rod of copper, with which the surface of the earth was tested in all directions and distances from the ground plate. If we imagine a line revolved around the ground connection as an axis, we can obtain a picture of the space taken by the fall of potential around the electrode and the distribution of this potential within that space, which will have somewhat the form of a funnel.



Figs. 2 and 3.

It is obvious that under all conditions the metallic ground conductor will have a potential different from that of the ground itself, always assuming that current flows, and that man, in case he stands on the ground, must not touch the ground conductor, unless he wishes to expose himself to danger, for man is in a condition of a shunt connection when compared to the resistance of the grounding. Consequently we must consider first of all the relation between these two resistances and second the current strength passing through these resistances, if we wish to determine whether there is danger or not. To estimate both conditions accurately is

therefore the duty of the engineer working out the project of a transmission line. But it is not at all necessary that a person should touch an object; under certain conditions all that is needed is to have him stand with feet wide apart on ground through which current flows, in such a way that the current paths run in the direction of the connecting line between the two end terminal points. If on the other hand the person



Figs. 4 and 5

stands on equipotential points, nothing can happen to him. There have been cases where this was well proven. A pole stood about 35 feet away from a ditch in which water ran. The switch on the pole, the iron parts of which were properly grounded, could be operated from the ground. A repairman who happened to be standing with feet wide apart close to the ditch gave orders to his lineman who was on the pole to close the switch. As the switch was faulty and a strong current passed through the ground to the ditch, the repairman, both of whose feet by accident touched two points in the direction of the current paths, was thrown to the ground by the shock, while the lineman at the pole went scot free, either because he stood on points of equal potential, or because he was better protected through the use of dry shoes.

The success of "grounding" of definite parts of the transmission system cannot be valued very highly after what was said before. The only certainty is that man, if he stands really on solid ground, has a potential different from that of the grounded parts, as soon as the ground electrode has current flowing through it. If danger is to be avoided, a person must be well insulated or else be brought to the same potential as the metal parts touched. It is only in this way that the desired goal can be reached.

What nature the currents have that flow to earth makes little difference, both energy and capacity currents can cause the development of a "voltage funnel" as shown in Fig. 1 and both must be treated differently. Quite fresuently we find the following occurrence: A current transmission line is connected with the ordinary porcelain upright insulators by way of iron poles or transmission supports. These iron poles stand in sufficiently moist earth and are connected according to the best of practice to ground plates laid in ground water levels. If an insulator breaks on such a line and if one of the conductors touches an iron pole, the conductor is properly grounded according to specifications and contact with it should be harmless according to theory. But we all know that in reality a man would escape death only by a miracle if he were to touch the pole or the conductor. Dry socks and rubbers are allies which are not to be despised when dealing with such a state of affairs.

Now if we imagine in place of the iron pole the iron tank or container of an oil transformer, which is properly grounded, and if we imagine in place of the broken insulator a faulty terminal connection, then the high-tension conductor above the oil container is "properly" connected to earth according to specifications. Contact with the oil container should therefore be harmless according to all book rules, but—it would be very unhealthy to make the experiment.

In both cases, no doubt, a capacity current flows to earth, but at the same time there appears a live current, if the neutral point of the transformers is grounded in the power house. Resistance and reactance of the power house grounding determine the strength and the phase change of the live current, which has a definite geometric relation to the capacity current.

We are able to limit the live current by regulating the resistance and reactance at will, but we must combat the capacity currents in other ways. First of all we must obtain a picture of the magnitude of capacity currents and here we may remember that they never pass beyond a maximum value, and this value can be estimated by rough calculations within limits accurate enough for practical purposes. We deal, in high-tension transmission systems, as a rule either with three-phase or with monophase systems. The normal charge current of transmission lines in good condition is as follows:

Three Phase System:

$$J_c = \frac{\text{Kilovolt} \times \text{Kilometer}}{550}$$

Monophase System:

$$J_c = \frac{\text{Kilovolt} \times \text{Kilometer}}{630}$$

The current flowing from the conductor to earth at any faulty place is:

Three Phase Current:

$$J_f = 1.4\ J_c$$

Monophase Current:

$$J_f = J_c$$

For lower tensions (10 to 20 kv.) the above values are a trifle too low and for higher tensions (40 to 100 kv.) a little to liberal. The difference might be 10 per cent of the more accurately figured values. Using the above rough estimates we can consider some phases of the following condition.

Assume a high-tension transmis-

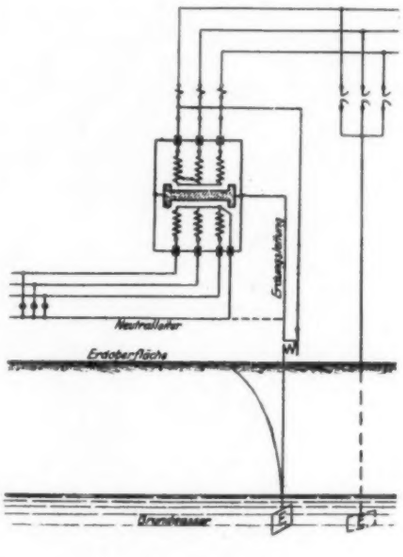


Fig. 6

sion line of 15,000 volts running over a distance of 1,000 km. (600 miles). Imagine that a three-phase transformer of from 40 to 60 kw. is connected to this line. According to general usage the transformer is kept in a brick or concrete transformer house, usually with a cement floor, having the switches, measuring instruments, oil switch, protective devices for high and low tension mounted on an iron support. This

support as well as the oil container of the transformer are properly grounded by conductors leading to the outside of the building, which ends in the ground plate at ground water level.

Under normal conditions, i. e., when all insulators, conductors and cables are in good condition, no current will flow through the ground conductor, because the charges neutralize each other. But this favorable condition changes as soon as, through some fault in the insulation, there arises a connection between the ground connection and a phase of the system. The charge current flowing to earth will be according to the equation above:

$$J_f = \frac{15 \times 1{,}000 \times 1.4}{550} = 38 \text{ amperes.}$$

It is hardly conceivable that any of the usual groundings can stand such a high current without having the intermediate resistance increase continuously, due to the drying out of the surrounding earth, and thus making the grounding worse. Normal grounds are designated as satisfactory, if they possess an intermediate resistance of about 20 ohms. At this resistance there takes place a voltage drop of $20 \times 38 = 760$ volts, which increases constantly owing to the passing of current.

This voltage drop is probably the cause of the danger to man. But it is much more important to know what current strength can pass through the human body under the most unfavorable conditions, as soon as the person is connected into the circuit, whether voluntarily or involuntarily. But this depends not on the voltage alone.

The windings or coils of the normal transformer have a considerable capacity when taken in ratio to the iron core, so that current flows through the connecting conductors between transformer iron core and earth even under those conditions when the connecting terminals are properly insulated. The coil of a monophase transformer of 60 kva. was connected for experimental purposes between two conductors of a 15,000-volt alternating-current transmission line. The voltage between iron core and earth was near 4,500 volts, as was to be expected. The current flowing through the ground conductors was determined at 2 milliamperes and is so small that it has no danger for human life. This current strength therefore is not determined by the voltage of the iron core of 4,500 volts, but is limited by the apparent "capacity" of the iron core, which in this case was estimated at 0.00143 mf.

What current voltages can be of danger to man is a matter of dispute. It seems to be certain that currents up to 100 milliamperes flowing between both hands or between hands and feet can be experienced without harm. If the current strength goes beyond this limit, say to double or triple that limit, death will be caused by the ceasing of the heart beats, probably a paralysis of the heart muscles. There are reports that there is also a maximum to the dangerous currents, as very high-tension currents are said to have passed through the head of a human being without causing death. However true this may be, it is a fact at least that more persons are killed on lines with comparatively low-tension (500 volts) than on lines with high tension

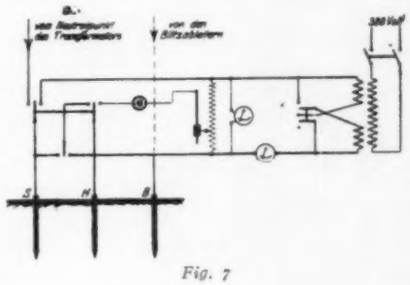


Fig. 7

(10,000 to 100,000 volts). But in making this statement we must remember that the danger from high-tension lines is impressed deeper on human consciousness than danger from lower-tension lines, and that the protective measures on the high-tension lines are more perfect and more numerous than those on low-tension lines.

We can say with certainty only, that currents which are limited to 100 milliamperes are of no danger to man, even when his resistance is zero, which is very rarely the case, and that in this consideration we do not figure the insulating effect of clothing and shoes. We know also that we cannot construct either a low-tension or a high-tension line without shutting out danger of any kind, but we also know that the protective measures taken to avoid or reduce danger from high-tension transmission systems are well developed enough to reduce fatal accidents down to a minimum.

We have already considered the effect of live currents when passing to earth in the shape of the much feared "voltage funnel" (Fig. 1) and will now consider another phenomenon, the so-called transmission from high voltage to low voltage. We must find out how it is possible, that between two closed current circuits, which are well insulated, but are bridged at one place, there can be a flow of current. For this we need one body, earth, in relation to which both circuits have a considerable capacity, and second the bridged points of the two current circuits must have different potentials.

For the sake of simplicity let us assume two electrically separated monophase circuits, each of them insulated by itself. Fig. 2 may represent the windings of a transformer. If the capacities of both circuits are to be neglected we can connect any desirable points with each other without obtaining current in the connecting line, and there will then be no transmission or stepping over of current. But in reality, especially in extensive systems, both current circuits have considerable capacities towards earth. If the capacities are $c_1 = c_3$ *and* $c_2 = c_4$ then the voltages of the conductors are equally great towards earth in all the conductors and we have:

Conductor 1 = + 7,500 volts in relation to earth.

Conductor 3 = — 7,500 volts in relation to earth.

Conductor 2 = + 110 volts in relation to earth.

Conductor 4 = — 110 volts in relation to earth.

Under these conditions it is not immaterial any more what points of the two circuits are connected with each other; only points of like potential may be bridged, without having current flow, e. g. the central points *7* and *8*. Matters are different if a conductor, perhaps *1* (Figs. 4 and 5) has its circuit closed with earth, so that the condenser c_1 has the same potential on both sides. Then the point *7* does not have the earth potentials = 0 any more, but has —7,500 volts and the conductor *3* has —15,000 volts as related to earth. Now if there is a connection between points *7* and *8*, the condensers c_2 and c_3 are changed with —7,500 + 110 c_4 with —7,500, —110 volts, and the conductors *2* and *4* obtain this voltage as related to earth and consequently we have a dangerous high-tension current in the low-tension circuit. As in general the con-

denser values of c_2 c_3 and c_4 are very low, the capacity currents are probably also very small. They can be measured by placing a milli ammeter between the low tension winding of the transformer (without load) and the two conductors *2* and *4*.

But the conductors *2* and *4* must not be touched with the hand, if the person stands on the ground, for this would be equivalent to connecting oneself in parallel to the condensers into the circuits, and the charge current of the entire transmission system would pass through the body, weakened only by the comparatively low resistance of the human body. This is true only if the connection between *7* and *8* is made, and this can occur only through some unfortunate accident, for example, through a contact of current between two coils a case which is exceedingly rare. As a rule there will be a short circuit first, which in itself will disturb the transformer and bring it to the point of cutting off all current through the excess load imposed on it.

If we omit the case just mentioned as not being a real so-called "transmission of current from high tension to low tension," we have the following conditions for a real transmission. 1. A bridging between the two current circuits, whose resistance need not come very close to zero; 2. Considerable capacities between the coils or between transformer coils and earth; 3. Such a distribution of capacities that there is considerable voltage between the two points, between which the bridging quoted in case 1 takes place.

In nearly all transmission systems conditions 2 and 3 are usually to be found and further the neutral conductor of the alternating-current system is grounded. This has its advantages in some ways, but also carries the danger with it, that in case of current transmission between low and high-tension line through the grounded neutral line the capacity current looks for a path to earth and causes considerable voltage between the neutral conductor and earth. Whether contact on the part of a human being with the grounded neutral conductor and with the current flowing through is sufficient to bring about death depends partly on the intermediate resistance of the ground conductor, partly on the extent of the transmission system, the condition of insulation of the surface on which the person stands and the resistance of the person himself, including his clothing and shoes.

The difference in potential between neutral conductor and earth exists simultaneous at all points, where the neutral conductor is laid, but persons do not touch this line at all places on the line, and very likely nobody touches the line at the moment of current transmission between the circuits. Even if it is impossible to reduce the resistance of the ground conductor to a point where all danger disappears, it is possible to use the capacity current flowing to earth for purposes of cutting off the transformer from the line and thus to limit the greatest danger to fractions of a second. Fig. 6 shows such a condition.

TO REDUCE DANGER.

It might be advisable to add the following instructions to reduce chances of fatal accidents: "At all places where energy is taken from high tension conductors to transform the same into low tension current for service use, it is advisable to connect a device into the ground connection, which automatically interrupts the connection to the high tension wires connected to the transformer and thus cuts off the entire substation from the system, as soon as the ground conductor has charging or other live current flowing through it." This protective device can be used with success only if the neutral conductor also is insulated, for if the same were grounded at a second place or at several places, the charge current would distribute itself depending on the resistance of the groundings and would be weakened so much that no discharge could take place.

The automatic cutting off of the transformer from the current source reduces the danger to the user to a minimum. But unfortunately a similar reducing of danger is not feasible at pole ground connections in overhead transmission lines without considerable additional cost. About the only thing that can be done is to connect all poles or else the ground connections and ground plates with one another by means of a metal conductor. Then the charge current divides into as many divisions as there are groundings, and the voltage drop becomes lower in proportion as the individual charge current strength, which is distributed to the individual ground plates. But even here practice unfortunately does not always bear out theory, as numerous accidents have shown, and the danger is added of having not only the pole a source of danger where the original fault occurred, but also all the other poles, which are connected by the metallic conductor. A better plan is to demand as perfect an insulation as possible for all supports and equipment used with iron poles and to avoid grounding of the iron poles altogether.

There remains the question how to determine the value of grounding objectively. Unfortunately there is much confusion in this relation. We can hardly use the electrical resistance alone as a criterion, for we can imagine a condition where the ground connection whose resistance is very low when all things are in order offers no protection whatever under adverse conditions. Imagine a ground plate laid in a tank filled with water but otherwise insulated. The ground materials which are used when making the measurements are dipped into this same water and the grounding will give a very low resistance, whereas, practically the measurement is worthless. It has even been advised by some engineers to make troughs of loamy material into which the ground plates are laid and which fill with rain water and are supposed to give a splendid ground connection. But such loamy moulds might be entirely impervious to water and would then have an entirely contrary effect to the one desired. In addition there is the second difficulty that the resistance of the ground varies very much with the weather and changes even by means of the current passing through the earth, which warms the latter and makes it more conductive and even insulating. It is therefore essential to test the resistance of the ground from time to time in order to take measures to ward off any impending danger due to unusual conditions. But such tests must be made quickly and must not demand an unusal degree of intelligence or effort on the part of the lineman making the test. Such an apparatus is shown in Fig. 7. The wiring is similar to the well known bridge and has the advantage that the electrodes during measurement can be passed through by any desired current, while the auxiliary electrode remains without current and thus has no effect on the distribution of current in the ground.

Tests have shown that after the bridge is once set, it is only necessary to read off the entire current shown by the ammeter in order to determine whether the resistance has changed. Only if there are considerable variations in the reading it becomes necessary to change the set of the bridge to see which of the two groundings has changed. For bridge wire a resistance of about 1,000 ohms is used, which is wound on a porcelain insulator and which has an adjustable rider. An ordinary telephone is used for the zero instrument. The measuring transformer can be made either for 110 or 220 volts or any other voltage. The total cost of this equipment is very low and the advantages offered by knowing variations in the nature of the ground near ground connections and the resulting necessity for changes would more than pay for itself in a short time. The following points of the high tension line and preceding article:

1. Touch no possible current carrying part, especially nothing that is grounded.
2. Have no pole or support groundings in connection with open air lines.
3. Have high and especially inductive resistances between neutral points of the high tension line and earth at the power station.
4. Ground conductors should be kept currentless, any currents flowing to earth should be used to cut off current supply as quickly as possible.
5. Under each terminal list the cir- tension lines should be insulated; but at the power station or at the substation it should be grounded over an automatic cut-off apparatus.
6. Groundings should be constantly kept under control.

—*Elektrotechnische Zeitschrift.*

Annual Telephone Report for Manitoba

The annual report of the telephone department of the Province of Manitoba, Canada, shows total assets of $13,510,403; investment securities, $1,350,000; replacement fund, $511,850; total valuation of the plant, $9,696,982.

The number of exchanges in operation at the close of 1918 was 51,760, a net gain of 2,853. The net increase in revenue exchange was $981,723 or 6.76 per cent; increase of toll revenue $63,936 or 17.31 per cent over the previous year. There has been no advance in rates although many tariffs in the dominion were advanced. The operating expenses were $87,390 higher and cost of maintenance increased $55,443. The sum of $41,012 was paid to employes enlisted for war service. The total increase for the year amounted to $142,834, and notwithstanding the higher cost of practically everything, there was a credit balance of $18,766; the operators' wages were increased which acounts for $63,856 in the operating costs. During the war period, the cost of operation in wages, materials, and supplies increased to such an extent that little work was done during the year in the way of extensions. The long-distance service was improved by installing copper circuits consuming 282 single miles of copper wire.

In the service of the department, 355 men and 870 women and girls are employed, making a total of 1,225 operatives.

A great deal of work has been planned for the coming year, which will give employment to hundreds of linemen and electrical workers, providing the labor conditions warrant the beginning of the work. The automatic system is to be installed to a considerable extent during 1919; the manual system, however, will be worked in conjunction with the automatic until the latter installation is completed. In connection with this installation is the condition that a factory be established in Winnipeg for the manufacture of all parts that could be manufactured here. This will be the first factory for the manufacture of automatic telephone equipment in Canada.

New York Hotel Has Largest P. B. X.

The size of the private telephone exchange grows with the erection of every hotel or office building of any considerable proportions. The largest ever constructed is that of a New York hotel which has been recently opened to the public. It occupies 3,165 square feet of floor space, having an operating room 110 feet long and 25 feet wide, a terminal room 30 feet long and 25 feet wide, a rest room 23 feet by 15 feet and a locker and washroom 30 feet by 14 feet. The operating force consists of one chief operator, one assistant chief operator, 8 supervisors and 110 attendants. The switchboard consists of 23 positions. Thirteen positions are equipped with telautographs used for paging and announcing only. The switchboard has a capacity of 3,340 extensions and 180 trunks.

The big hotel has telephone service in each of its 2,200 rooms, and there are 40 public telephone booths served by four switchboards, connected with the main switchboard. The following gives some idea of a few of the items which make up part of the telephone system: Six hundred and thirty fuses, 1,170 condensers, 2,400 relays, 5,350 lamps, 83,500 jacks, 750,000 soldered connections, 7,926,000 feet of wire.

Belgium Rebuilding Its Telephone System

When the Germans destroyed the telephone system of Belgium, they calculated that it would take two years to restore it. The two chief central exchanges at Brussels were entirely removed, and the third was destroyed. The heads were cut off 50 underground cables, each made up of from 200 to 400 wires, while separate wires were cut in several places in such a way as to make them especially difficult to repair. Equipment was torn down and removed; one of the big "multiples" was entirely destroyed. The whole telephone installation will have to be rebuilt and the work is now going on.

Exchanges in other towns suffered the same fate. The wires in private houses were cut, and in many cases the instruments themselves were removed.

The same conditions prevail at the Central Telegraph office. The great switchboard serving as an exchange for the whole of the country was stripped. The main instrument room was left simply empty. At the end of March there was no cable communication with England, except by way of Holland and France. There was only one wire working between the French frontier and Paris. It was four and one-half months before the Germans succeeded in discovering, although it had been laid by Siemens, how the Belgians had managed to keep the underground telephone line from Antwerp working surreptitiously for days after the occupation, in spite of the most thorough search by the invaders.

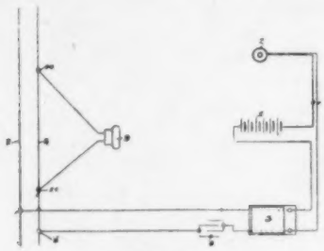
Telephone Patents Recently Issued

A Brief Digest of the Most Interesting Current Specifications

By DAVID S. HULFISH

NO. 1,319,725. Automatic Switch. Issued to John N. Reynolds, assignor to Western Electric Company, Inc., New York. The brushes of the switch are driven in continuous movement by motor power, and are stopped in desired position by a mechanical stop which has been set by control of the impulses from the callsender.

1,319,774. Receiver Holder. Issued to Lazarus S. Kallajian, Boston, Mass. An auxiliary base is provided with a guide, against which the vertical column of the telephone is placed; the receiver then is in position for the ear of the telephone user, or in position to operate the telephone hook lever, as required.



1,321,543

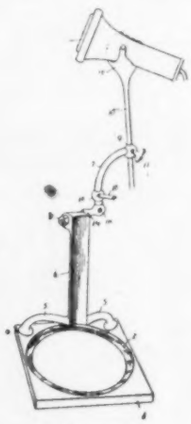
1,319,933. Transmitting System. Issued to W. P. Stunz, assignor to G. R. Webb, Baltimore, Md. An unusual arrangement of parts for repeating or amplifying speech waves. The transmitter with its battery energizes two windings which act through two shafts, to influence the internal relations of two sets of transmission cells, the transmission cells are fed by a battery, and they supply the transmission current upon the outgoing line.

1,319,999. Operator-Call System. Issued to C. L. Goodrum, assignor to Western Electric Company, Inc., New York, N. Y. When an automatic connection has been established, the telephone user may operate his dial to call a manual operator, the callsender operating to display a lamp signal adjacent to a jack by which the operator may speak upon the connected line.

1,320,715. Recall System. Issued to F. M. Slough, assignor to Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. In a manual cord pair, the cut-off relay of the calling line is charged first through a circuit containing the back contact of a relay connected to the ringing plug, and later through the front contact of a relay associated with the answering plug. Should the calling subscriber operate his hook lever, the first depression of the lever will release the cut-off relay and subsequently the flashes will be seen upon the line lamp of the calling line. The attention of the operator being normally upon her line lamps, the recall flashing is more readily noticed.

1,321,171. Receiver. Issued to Maximilian Weil, New York, N. Y. The receiver's case contains several small receiver elements, each with its own diaphragm, all of them effective upon the user's ear through the one earpiece.

1,321,543. Fault Locator. Issued to W. H. Niswonger, assignor to William S. Darley, Chicago, Ill. A battery and buzzer are in series with the primary of an induction coil. The secondary of the induction coil is connected across the telephone line which is in fault. A receiver of low resistance is connected to two points upon one of the lines in fault, connecting first at one side of the buzzer attachment, and then at the other side, and the louder buzz will be heard in the connection toward the fault, because the greater current from the induction coil will be passing in that direction.

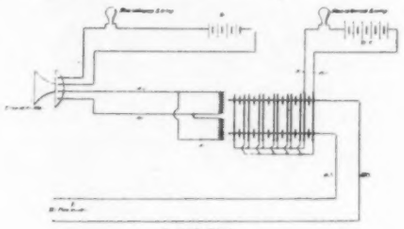


1,319,933

1,321,870. Keyboard. Issued to G. D. Wolf, assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. The novelty which forms the basis for this patent lies in the manner in which the keys are mechanically fastened in the keyboard.

1,322,025. Automatic Switch. Issued to A. E. Keith, assignor to Automatic Electric Company, Chicago, Ill. In a set of automatic switches, the operating shaft is common to the switches of the set. A switch is connected to the operating shaft and then that switch may be operated independently of the other switches.

1,322,170. Callsender. Issued to M. F. Hill, assignor of part to E. E. Clement, Washington, D. C. Originally filed 1908; original patent 1,253,688; divided 1918. An electrical impulse sending machine, suitable for use of operators in a central office for operating the automatic switches of the central office.



1,319,774

1,323,483. Telephone System. Issued to T. G. Martin, assignor to Automatic Electric Company, Chicago, Ill. Application filed 1916; 140 claims. The signaling is of the two-wire system; the signals are received upon relays at the Keith line switch and the impulses are repeated upon the trunk side of the condensers.

Paducah Gets Same Rates for Another Year

Rates now being charged by the two companies at Paducah, Ky., were perpetuated for a period of one year by resolution of the mayor and commissioners. The resolution sets forth facts indicating that neither of the local companies can operate and earn a justifiable return on their investments on the old sechedule of prices which obtained before the war. They cite that rates now charged for business and residence telephones have been approved by the government and seek to retain them as necessary to meet increased cost of service.

Of Interest to the Trade

What the Telephone and Accessory Manufacturers are Doing to Advance the Art

The Anderson Toll Set for Better Service

The Anderson Toll Set is a device designed and patented by C. A. Anderson, superintendent of equipment of the United Telephone Company, of Abilene, Kan.

Mr. Anderson saw the need for this device upon investigating the causes for indifferent service on multi-station toll lines, and that the sets have been a success from the start is apparent from the fact that the United Telephone Company has installed over one hundred and twenty-five of the Anderson Toll Sets in its territory since the first ones were tried out over three years ago.

The arrangement is similar to the plug ended trunk plan as used on the trunking positions of the larger switchboards and since there is only one plug and cord used in making a connection between toll line and subscriber on a switchboard equipped with a toll set, the service is uniform and is not dependent upon the condition of perhaps fifteen pairs of end circuits on a switchboard.

Mr. Anderson made an exhaustive study of the service on multi-station toll lines and found that service was bound to vary greatly when connecting toll lines to subscribers in small switchboards for the following reasons:

1. Operators would not at all times use repeating coils in connecting grounded lines to toll lines.
2. Defective (or partly so) cord circuits were used on important connections sometimes making it necessary to repeat messages or cancel same.
3. So-called local stations would pass calls between themselves and fail to make tickets which resulted in lost revenue.
4. Slow service due to the fact that at "non-owned" offices the number of cord circuits would be limited and all cords were sometimes busy.
5. Low-bridges caused by unauthorized changes in "non-owned" offices.
6. Poor facilities for testing toll lines as the bridges show up on the volt meter.

The idea of the toll set is a good one, as it interposes the toll line company's apparatus between the switchboard plug and the toll line. In other words, the toll line company owns their own connecting links and do not have to depend upon the cord circuit equipment in small switchboards.

The equipment consists of a repeating coil, a special switchboard key and a "clear-out" drop along with specially designed condensers all mounted in a neat cabinet which can be placed on the side of the switchboard. The toll set is so easily connected that the ordinary telephone man can wire it in. The plug associated with the toll set is placed in a convenient place in the switchboard, usually there is a vacant place for it.

The switchboard keys used in the Anderson Toll Set are made special to fit the circuit by the Kellogg Company. Durability is attested to, through the fact that the maintenance at a station equipped with an Anderson Toll Set is even lower than one without.

The United Telephone Company finds that these sets have so much improved the service that the saving encountered makes them a good investment. Especially so when the sets are used to gain an extra circuit.

Reinke is Kellogg Sales Engineer in Europe

A. E. Reinke, who has recently been appointed exclusive representative for the Kellogg Switchboard & Supply Company for the countries of Holland and Switzerland, was born and raised in Chicago. He attended the Chicago Manual Training School and later, in 1896, graduated from Cornell University.

E. A. Reinke.

Shortly after his graduation, Mr. Reinke entered the employ of the Western Electric Company. He was with that organization for twenty-three years in European fields, working up to the position of Chief European Engineer. During this time he assisted in developing the European common-battery practice.

In August, 1919, Mr. Reinke resigned his position with the Western Electric Company to take over the sales work for the Kellogg Switchboard & Supply Company in the above mentioned countries.

His long experience in foreign countries, large acquaintance in the European telephone field and knowledge of languages will no doubt prove valuable assets and insure success in this, his new undertaking.

Stromberg-Carlson Repeating Coils

A number of years ago the Stromberg Company produced a very compact design of repeating coil which mounted in the same space as a double relay shell, and was adapted to mount interchangeably with relays on standard mounting plates. This repeating coil, known as the No. 11-A, gives very high efficiency for voice transmission. In obtaining this high efficiency, a closed magnetic circuit of silicon steel laminations was used, the windings being correctly proportioned and located on this laminated steel core so as to obtain the best results for transmission of high-frequency voice currents. Incidentally this No. 11-A repeating coil has sufficient iron in the core to allow the passage of low frequency ringing currents so as to ring telephone bells or operate switchboard drops. However, this coil is not intended to be a ring-through coil, the same as the Stromberg No. 12-A, which occupies more space and is designed for phantom circuit and similar uses.

When the Stromberg-Carlson No. 105 switchboard was designed it was necessary to provide a repeating coil similar to the No. 11, giving high transmission efficiency but with the iron and winding so proportioned so as to prevent ringing through the

cord circuit, and consequent operation of drops or ringers on connected circuits; in other words, to make the circuit non-ring-through and positive-ring-off and also to allow the use of double clearing-out drops.

The coil which was finally designed to produce the latter results is known as the Stromberg-Carlson No. 13-A and occupies the same space as the No. 11-A, and mounts interchangeably with Stromberg relays on regular mounting plates.

This No. 13-A repeating coil is a remarkable development, as it allows of very high efficiency voice transmission and when connected in the double clearing-out circuit of a No. 105 switchboard, absolutely prevents ringing current operating clearing-out drops or ringers connected to the other half of the cord circuit. The improvement over similar coils can be expressed by saying that the loss due to these other coils, when connected in so-called "non-ring-through cord circuits," is three to six times that of the Stromberg No. 13-A repeating coil arranged in the type of cord circuit furnished in the No. 105 switchboard. This does not completely express the difference, as the other designs of "non-ring-through" repeating coils still allow a sufficient amount of ringing current to get through the circuit to operate the connected drop or tap the ringers on the connected line under certain conditions.

While the magnetic circuit of the No. 13 repeating coil is not completely closed, the proportioning of the iron and winding is correct to obtain the desired results as regards non-ring-through features, and at the same time produces only slightly greater high frequency transmission losses than the No. 11-A "talk-through" type of repeating coil.

Another feature of this No. 13-A repeating coil is the fact that it can be used in universal cord circuits of common-battery multiple switchboards, thereby allowing of double supervision without interference in the operation of the clearing out signals, which is present when the regular designs of talk-through repeating coils are used. There is a sufficient amount of iron in the core of this No. 13 repeating coil so as to allow talking current battery to be fed through its windings without producing additional high frequency losses by the presence of these currents. In other words, repeating coils which might give fairly high efficiency when used in magneto circuits in which only high efficiency voice currents are projected through the windings, often will give much lower transmission efficiency if direct current from the central office battery also is fed through these windings to supply talking current to connected central energy telephones. Both the Stromberg No. 11 and No. 13 repeating coils are designed to avoid this kind of battery feed loss.

Michigan State Passes Preferred Dividend

The Michigan State Telephone Company has discontinued dividends on its preferred stock. The dividend rate has been 6 per cent, with no dividends to the common stockholders since 1914. In a statement to stockholders the company says applications for increased rates to cover the rising costs of operation and maintenance have been before the state commission continuously since 1913. A small increase was granted two years ago, but an injunction secured by the city of Detroit prevented this becoming operative.

When the government took over the property as a war measure rates were advanced, but the application of new rates was delayed until about six weeks before the government relinquished control. When the government gave up control the state commission revised the rate schedule downward with the result that in the next four months the company's loss was reported at $506,000. For the 11 months ending with November the company's gross earnings were $10,785,073 and after paying operating expenses a net sum of only $502,401 remained. This was enough to pay the 11 months' interest of $447,650 on the company's bonded indebtedness and left only $54,751 to make an interest payment of $881,835 on outstanding notes.

The company has made application for increased rates, but this will take time and emergency relief has been asked. In view of conditions the suspension of the preferred stock dividends has been considered advisable.

The St. Louis sales office of the Standard Underground Cable Company, E. J. Pretzcker, manager, on February 1 will be removed from the Security Building, where it has been located since 1897, to the Arcade Building.

Switchboard Instruction Book By Stromberg

Ray H. Manson, chief engineer of the Stromberg-Carlson Telephone Manufacturing Company, has written a new book. It is devoted to the equipment of his concern, and is entitled "No. 105 Switchboard Instruction Book," but just the same it is a regular text book on modern magneto practice, and will add value to any telephone library. Those who know Mr. Manson and his firm—and that includes all telephone men—need scarcely be told that the reliability and accuracy of the work are assured.

"Northwestern Bell" Is New Magazine

The northwestern group of Bell Companies, with headquarters in Omaha, has blossomed forth with a brand new magazine for its employes —"The Northwestern Bell." To those familiar with the editorial and typographical excellence of all members of this family of publications, it is sufficient to say that the newcomer measures up to their best standards. The first issue contains stories and pictures of more than ordinary interest.

The three principal cities of the State of Rio Grande do Sul, Brazil, (Porte Alegre, Pelotas, and Rio Grande) are about to renew the plant of their telephone networks. That of Porte Alegre numbers 10,000 lines, wth 5,000 subscribers; Pelotas has 5,000 lines, and Rio Grande 2,000. Other towns, such as Bage, Caxais, Santa Cruz, Sao Leopoldo, and Cacholera have smaller networks, but the aggregate totals a large figure. The telephone company which is established in the Republic is now considering plans for the extension of its operations.

Federal Judge Trieber dismissed a suit filed by the city of Little Rock several months ago against the new rates installed by the Southwestern Bell Telephone Company. After dismissing the suit he ruled that the city pay all costs.

A catalog of telephone protectors, terminals and supplies, recently issued by the Cook Electrical Company, formerly the Frank B. Cook Company, is unusual in both its contents and its excellent make-up.

Public Utility Commission News

Reports Concerning the Activities of State Authorities in the Telephone Field

Florida

THE state railroad commission denied applications of the Southern Bell Telephone Company and 34 Independent telephone companies of the state for a continuation of the higher rates fixed by Postmaster-General Burleson during the period of government control. The commission also restored moving and installation charges to the pre-war status.

Illinois

The state public utilities commission has announced its decision relative to the rates for telephone service of the Murphysboro Telephone Company.

The new rates are effective in the following cities:

Murphysboro, Carbondale, Campbell Hill, Ava, Marion, Herrin, Carterville, Cambria, Creal Springs, Johnston City, Pittsburgh, Duquoin, Willisville, Benton, Thompsonville, Christopher, West Frankfort, Royalton, Ewing, Sesser, McLeansboro, Anna, Cobden and Jonesboro and vicinities.

The company is ordered to discontinue its existing rates in these cities and to place in effect the new rates authorized by the commission.

The order carrier a reparation clause. If further investigation discloses the rates to be excessive, the company is to make refund with interest at 5 per cent.

The yearly rates authorized for Murphsboro, Marion, Duquoin, Benton and West Frankfort follow:

Individual line, business, $42; two-party line, business, $36; party line rural, business, $27; extension, business, $12; individual line, residence, $27; two-party line, residence, $21; extension residence; $6; party line rural, residence, $21; service stations, $9; service stations (limited), $6.

An order authorizing the Christian County Telephone Company to increase its telephone rates in Taylorville, Pana, Morrisonville, Edinburg, Owaneco and Kincaid was issued by the state public utilities commission.

The increased rates became effective January 1, 1920, and are as follows, compared with the old rates:

In Taylorville, Pana and Kincaid—individual business lines, old rate $33 a year; new rate $36 a year. Two-party business lines, old rate $27; new rate $30. Individual residences, old rate $18; new rate $24. Four-party lines, old rate $15; new rate $18. Rural, old rate $18; new rate $21.

In Morrisonville, Edinburg, Stonington and Owaneco—individual business lines, old rate $24; new rate $27. Two-party business line, old rate $18; new rate $21. Individual residence lines, old rate $15; new rate $18. Four-party line, old rate $12; new rate $15. Rural, old rate $12; new rate $15.

The public utilities commission allowed the Gillespie Home Telephone Company the increases in rates for which it had petitioned. The increased annual rates, which are as follows, became effective January 1:

Direct line, business, $39; two-party, business, $33; direct line, residence, $27; two-party, residence, $24; four-part, residence, $21; rural, multi-party, business, $27; same, residence, $24.

The above rates are payable in advance and a discount of 25 cents per telephone is allowed if the bills are paid before the 15th of each month.

The commission up to the present time has taken no action on the petition of the Staunton Telephone Company. The increases asked for by the Staunton company are not as large as those granted Gillespie, amounting to approximately 50 cents per month more than the rates now in effect there.

The following orders were made public by the state public utility commission:

Suspending until May 12, proposed rates for telephone service in Divernon filed by the Union Telephone Company.

Permitting the Litchfield Telephone Company to place in effect as of January 1 or any subsequent date after ten days' notice to the commission, the schedule of telephone rates for Litchfield now on file with the commission. The company is ordered to set aside $291.66 monthly as reserve for depreciation.

The Illinois public utilities commission issued an order authorizing the Leaf River-Egan Telephone Company to place in effect as of January 1, 1920, its proposed increase in telephone rates at Leaf River.

Application of the Kinloch-Bloomington Telephone Company to purchase the exchange and other property of the Central Union Telephone Company at Bloomington, Ill., was filed with the public utilities commission. The consideration would be $35,200 par value of the capital stock, and $83,500 par value of first mortgage five per cent bonds of the purchasing company.

Indiana

Evidence to support differential charges for the various classes of long distance telephone service was offered by representatives of Independent and Bell Telephone Companies at a general hearing on long distance tolls and charges held by the public service commission.

The differential charges were inaugurated by the postmaster general during the period of Federal wire control last year. Whether they will be retained in Indiana depends upon the action of the commission. Telephone representatives at the hearing said that any change by the commission on the charges for intrastate long distance service would result in serious complications because the Burleson charges are still effective on interstate messages and will remain in effect unless some action is taken by the interstate commerce commission.

C. R. Woods, Chicago, general traffic manager for the Central Union Telephone Company, explained that 75 per cent of the long distance business of his company is in the class designated as "person to person calls." For this reason, he said, the charges for this class of service are really the base rates even though the "station to station" service is 20 per cent less and the "appointment calls" and "messenger calls" are 20 per cent higher.

He explained that the person-to-person rate is applied when the party calling asks to be connected with some particular person and that the station-to-station rate is applied when the person putting in the call will talk to any person at some special number.

The rates for person-to-person calls have been fixed arbitrarily, he said, and are not based on the actual cost of the service. The rates now in effect for this class of service are merely experimental, Mr. Woods said, and tests have shown that they are from 10 to 25 per cent lower than the actual cost of operation.

Members of the commission asked for an explanation of the fact that overtime conversations are subject to the rate under which the call was placed rather than the lowest long distance charge.

Mr. Woods said that the theory of long distant charges is that they are based on minute units, just as railroad fare is based on the mile. For this reason the charge applies throughout the duration of the call, he said.

H. A. Barnhart, president of the Rochester Telephone Company, and president of the Indiana State Association of Telephone Companies, said that he had trouble explaining to business men who have paid for person-to-person service why they have to pay more than the station-to-station rate for overtime. These telephone patrons take the position that the extra cost of the person-to-person service is defrayed during the first three minutes, he said.

It was insisted by Mr. Woods that the charge should be spread over the entire call.

In answering the question of the commission as to what was being done to educate the public about the different charges so that they could take advantage of the cheaper service, Mr. Barnhart said that the state association would join with the district associations in holding four meetings during the next year, which will be schools for instructing the employes of telephone companies. One of the meetings will be for chief operators and competent instructors will lay before them the working of the entire system so that the public can be guided in selecting the service desired when applying for long-distance calls. Other meetings will be efficiency schools for linemen, auditors and bookkeepers, he said.

The purpose of the schools, he said, is to educate the employes of the companies so that the entire system in the state can work in harmony. The result will be better service and greater satisfaction on the part of the public, he said.

Members of the public service commission related instances in their personal experience in which the telephone companies had failed to educate the public so that patrons might enjoy the lower rates under the Burleson classification of toll rates.

Not many persons are aware that they can telephone by long distance between midnight and 4:30 o'clock in the morning at one-fourth the regular rate, members of the commission said.

All the telephone companies represented at the hearing are in favor of a continuance of the Burleson rates. Representatives said that a return to the rates in effect in this state before the Burleson rates became effective would bankrupt many companies because of the increased cost of labor and material.

A petition has been filed with the public service commission by the Central Union Telephone Company asking permission to acquire and hold securities of the Citizens' Independent Telephone Company of Terre Haute. The securities are to be paid the Central Union Company in consideration for the latter's exchange at Terre Haute. They include $192,000 capital stock, $379,400 first mortgage 5 per cent bonds and $240,000 6 per cent refunding and extension bonds.

The Modoc Telephone Company has been granted permission to increase its rates to $1.50 net, except individual telephones in business houses for which $1.75 can be charged. The company must maintain a 24-hour service.

Announcement has been made by the public service commission that the hearing of the petition of the Carrol Telephone Company for increased rates has been postponed indefinitely, because the petition for increased rates has been withdrawn by the company. The telephone company was going to meet opposition to increased rates with the present service and the opposition was in the nature of a petition for a franchise for another company which is promising improved service and satisfactory toll rates between Delphi and rural telephones. A number of petitions are in circulation which will be submitted to the public service commission when the new company has a hearing for a franchise.

It is ordered by the commission that the Farmers' and Merchants' Co-operative Telephone Company of Boswell, Indiana, be authorized to file with the commission a supplemental schedule, changing the date of discount for payment of bill as follows:

A discount of 15 cents per month to residence subscribers whose bills are paid on or before the 15th day of the month in which service is rendered.

A discount of 25 cents per month to business subscribers whose bills are paid on or before the 15th day of the month in which service is rendered.

A discount of 45 cents per quarter to all subscribers whose bills are paid on or before the first day of the second month of the quarter in which service is rendered.

It is further authorized to discontinue service to subscribers who fail to pay their bills on or before the first day of the month succeeding the month or quarter in which service is rendered.

The supplemental schedule applies to all subscribers of the Farmers' and Merchants' Co-operative Telephone Company in and about the towns of Boswell, Freeland Park, Chase, Talbott, Tabb and Dunnington.

The commission has rendered its finding in the case of the Sharpsville Telephone Company, which was before that body asking permission to increase its rates.

After hearing the evidence the commission permitted the company to increase its rates as follows, effective January 1, 1920:

Single business line, $2 per month.

Single residence line, $1.50 per month.

Party line, residence, rural, $1.25 per month.

The commission also ordered that the company should set aside 5 per cent of the value of its depreciable property, which was found to be $16,500 annually, for a depreciation fund. The commission found that the value of the property for rate-making purposes was $20,000.

The commission found that under the old rates charged by the company that the income was about $1,500 less than enough to pay operating expenses, depreciation, and a return of 7 per cent on the investment.

The commision has ordered that the Eastern Indiana Telephone Company charge the following monthly rate for Winchester, beginning January 1, 1920:

Business, main line, gross, $2.50; net, $2.25.

Residence, main line, in town, gross, $2.00; net, $1.75.

Residence, party line, in town, gross, $1.50; net, $1.25.

Rural business party telephone gross, $2.00; net, $1.75.

Rural, residence party line, gross, $1.50; net, $1.25.

Rates on the following exchanges: Lynn Redkey, Farmland, Ridgeville, Fountain City, Parker, and Saratoga will be:

Business, main line, gross, $2.25; net, $2.00.

Rural, business party telephone gross, $1.75; net, $1.50.

Residence, main line, in town gross, $1.75; net, $1.50.

Residence, party line, in town gross $1.50; net, $1.25.

Rural residence, party line, gross $1.50; net, $1.25.

The commission authorized the consolidation of eight telephone exchanges in Jackson and adjoining counties by the organization of the Southern Indiana Telephone & Telegraph Company. The new company is composed of J. B. Thompson, H. H. Carter, L. C. Griffiths, J. H. Andrews and J. V. Richart.

In its proposals to consolidate the companies now under its control, the new company offered to take them over at a total valuation of $240,000. The commission, however, refuses to permit the consolidation on that basis and fixed the aggregate valuation at $200,000.

The Seymour property is the largest of the group. The new company desired to buy this system at $80,000 but the commission reduced the valuation to $66,666.

The companies in the consolidation, the price proposed for each and the correct price allowed by the commission follows:

Seymour Mutual Telephone company: Proposed price, $80,000; corrected price, $66,666.

Home Telephone Company of Brownstown: Proposed price, $32,000; corrected price, $26,666.

Home Telephone Company of Bicknell: Proposed price, $32,500; corrected price, $27,083.

Jennings County Telephone Company: Proposed price, $14,000; corrected price, $11,666.

North Vernon and Vernon Telephone Company, $42,000; corrected price, $35,000.

Butlerville Telephone Company: Proposed price, $1,500; corrected price, $1,250.

Scott County Telephone Company: Proposed price, $31,000; corrected price, $25,833.

Lexington and Little York Telephone company: Proposed price, $7,000; corrected price, $5,833.

Total proposed price of all the telephone companies involved, $240,000. Corrected price, $200,000.

The new company was authorized to issue common stock to the amount of $200,000 to raise revenue for the purchase of the stock. It was also permitted to issue $45,000 ten year seven per cent notes at not less than 94 per cent of par for the purpose of retiring present indebtedness.

The commission in an interlocutory order states its position in favor of the consolidation of telephone exchanges. The order is issued following a hearing which was held a month ago on petitions of both the Home Telephone Company and the Southern Telephone Company for authority to increase rates, and a petition filed by Col. Charles L. Jewett, head of the city law department, of the City of New Albany, for physical connection of the between plants of the Southern Telephone Company of Indiana and the Home Telephone Company, of Louisville. While in the finding of the commission it was stated that the final order directing the physical connection between the two telephone exchanges is withheld in order to afford the two companies concerned an opportunity to make a voluntary arrangement for the sale, transfer or physical connection of the telephone lines, at the same time the commission holds that the public convenience and necessity requires one and only one telephone utility in a given locality.

It is ordered that the final determination of each of the cases herein consolidated be postponed until March 1, 1920, in order to give the Louisville Home Telephone Company and the Southern Telephone Company of Indiana opportunity voluntarily to work out a plan of consolidation.

The commission has authorized the Garrett Telephone Company to put into effect a new schedule of rates, the primary business rate to be $3.50 a month; primary residence, $2.25; rural business, $2.50, and rural residence, $1.75. The rates are somewhat higher than those ordered in effect by the federal telephone administration last summer. The new rates are intended to yield the company 6.8 per cent on its estimated value of $90,000.

The commission authorized the Winona Telephone Company to issue $30,000 of 6 per cent preferreed stock at not less than 96 for improvement purposes.

The commission authorized the Franklin Telephone Company to continue in effect present rates established by the federal telephone administration last summer. The commission found the new rates "reasonable," the order says.

In answer to a supplementary petition of the Lafayette Telephone Company, the public service commission has granted the company permission to modify the original order in the cause for an increase in rates, recently allowed, the fact having been shown that the modification would bring about a reduction in certain fields of operation.

The finding of the commission follows:

On December 19, 1919, petitioner filed a motion to modify the original order in this cause, issued December 5, 1919, by striking out the following paragraph:

To the above base rates for individual business and residence telephone, there shall be added a line charge of 50 cents per month for each one-quarter mile of line, or fraction thereof, beyond the city or town limits.

Substituting in lieu thereof the following paragraph:

To the above base rates for individual business and residence telephones, there shall be added a line charge of 50 cents per month for the first four quarter miles of line or fraction thereof, and 25 cents per month for each additional quarter mile or fraction thereof, beyond the city or town limits.

By the modification prayed, the rates provided in the original order will be reduced. The commission finds that its original order should be so modified.

Michigan

Present temporary telephone rates in effect since August are not high enough, and Michigan State Telephone Company, through General Manager George M. Welch and At-

torney Eugene S. Wilson notified the Michigan public utilities commission that the company would ask for higher temporary rates in Lansing and the rest of the state.

Mr. Welch announced that the American Telephone and Telegraph Company had authorized the expenditure of $12,000,000 by the Michigan State Telephone Company for extension and betterment of service. It is believed that the greater portion of this money will be spent in Detroit and Flint, where thousands are unable to get service.

The two company's representatives did not make formal application. They announced that they would confer with Attorney General Alex J. Groesbeck, as representative of the Michigan League of Municipalities, and Assistant Corporation Counsel Wilcox, representing Detroit, with reference to the sought temporary increase rate.

At the time they conferred with the commission, these company representatives left a statement of revenues and expenses of the company from July to October.

This showed that the total operating revenues of the entire company for July were $1,144,028.77, in Detroit, $515,734.11; for August, $1,016,049.45 for the state, and $489,195.60 in Detroit; for September, $1,007,575 in the state, and $499,738.71 in Detroit; for October $1,052,072.49 for the state, and $521,426.88 for Detroit.

Over the same period, total operating expenses were: July, $927,147.27 for the state, $469,246.92 for Detroit; August, $755,160.28 for the state, and $404,342.51 for Detroit; September, $777,176.61 for the state, and $392,820.46 for Detroit; October, $862,625.46 for the state, and $451,559.44 for Detroit.

Missouri

Refusal of the public service commission to permit the Bell Telephone Company to retain the rates charged while the system was under government control has resulted in an appeal being taken to the circuit court. The case only applies to cities and towns of the state where the company has exchanges.

New York

People are talking more since the war—25 per cent more, if testimony given before Public Service Commissioner Thomas F. Fennell by T. P. Sylvan, assistant to the president of the New York Telephone Company, may be taken as a standard of measurement.

Commissioner Fennell was conducting an inquiry into deficiencies in telephone service, and Mr. Sylvan was giving the company's explanations of the deterioration.

"In January last," he said, "we needed 7,258 operators in Manhattan and the Bronx to give 100 per cent service. On November 1 we needed 9,190. The calling rate has become 20 per cent higher than it was a year ago, and each call has become 25 per cent longer. The former average per call was two minutes; now it is two and one-half minutes."

"Do you mean to say," asked Commissioner Fennell, "that people talk that much longer than they used to?"

"Yes, I do," replied Mr. Sylvan. "Everybody is talking more since the war. There is hardly any business done today that doesn't take much longer than it used to; it is so much more complex. The whole telephone plant has become distorted as a result."

"Just how?" asked the commissioner.

"Well, for example, you used to call up your grocer and say you wanted ten pounds of sugar, and that was the end of it. Now you call up and ask if you can have one pound, and he says you can if he gets the barrel he has been promised next Tuesday afternoon."

Mr. Sylvan, as did all the other company witnesses, said the company's greatest handicap was in getting enough operators, however. In Manhattan and the Bronx the shortage is nearly 650, although 2,481 were added in the first ten months, and although out of 14,889 applicants 3,430 were graduated from the company's two training schools.

"The present turnover is 37 per cent," he continued. "We are trying every device we can. We are employing old operators to come back in the evenings, girls who have got married, for instance, but are willing to help us out.

"We have brought into the city 147 out-of-town operators, and are keeping them in dormitories established for them. We are advertising in the newspapers, in street cars, in church and society periodicals, in our pay stations, on the doors of booths in sections of the city where the right kind of girls may be found.

"We pay a bonus of $5 for every available applicant that is brought in by girls already in our employ, and 55 per cent of the available ones have been got in this way. Six times during the present year we have raised wages—on January 1, April 2, May 5, June 27, July 30 and October 1—until the average yearly pay of female employes has increase from $659.80 to $841.91.

"The great trouble is shortage of operators. The equipment proposal, if it were possible to hasten that, would only add to our troubles, for we wouldn't have the girls to fill the new positions. We have apparently reached the stage, such is the competition for female help, where we are running in circles. In *The World* of a recent issue, there were sixty-five columns female help wanted advertisements. There is no market left that we can turn to.

"As a result we have had to turn to a project for mechanical switching, and by 1920 or 1921 that will be installed. This, however, will not affect our present force in any way. It will merely take care of our growth."

Then Mr. Sylvan read into the record the figures of resignations of operators during the first nine months of the last two years, classified by reasons. The tabulation was as follows:

	1918	1919
Marriage	447	856
Home duties	641	659
Return to school	111	182
Leaving city	238	266
Disability	373	269
Other employment	1,584	951
Hours of work	273	456
Wages	25	17
Other conditions of work	318	332
Discouraged	59	44
Miscellaneous	20	78
No reason given	16	15
Total	4,105	4,125

"The chances for getting married," commented Commissioner Fennell, "seem to have improved during the present year. Have you used that as an inducement?"

"We have worked it very hard," said Mr. Sylvan solemnly.

Then he offered figures of the dismissals, and the reasons therefor, during the same period. They ran as follows:

	1918	1919
Poor attendance	108	131
Poor work	88	105
Violation of rules	24	30
Disobedience	46	62
Undesirable	76	73
Miscellaneous	47	94
Total	369	495

The increase in the number of dismissals for what may be called disciplinary reasons have previously been brought out in the testimony of several chief operators examined.

"Attendance is poorer than it used to be," said Miss Jane T. Mooney of the Bowling Green exchange. "The

absentees run from eleven to twenty a day; they used to average six and seven. I don't know whether this is because they can afford to stay away, either on their own pay or on that of other members of their family, but we are having more trouble with girls off."

"The girls we get nowadays resent discipline," said Miss Anne M. Stack of Forsyth, which was formed to take the overflow from Orchard. "Then too they object to work in the evenings and at night; they object to work on Sundays and holidays. It isn't a thing of wages with us; it is a thing of time. The girl of today thinks more of having her evenings than she does of advancement. Boys? They wouldn't give the service girls do. A girl will listen and a boy won't."

"More wages wouldn't help," said Miss K. V. Pettit of Audubon. "Wages don't seem to bother the girls. It's the Sunday, holiday and evening work that they object to."

Miss H. M. Pendergast of Richmond Hill, Miss M. G. Cox of Main (Brooklyn) and Miss K. M. Schmitt who has for ten years been head of the training school for operators, all agreed that the trouble was to get enough girls and to keep them satisfied with their hours after they had been got.

"Have you tried," asked Commissioner Fennell, "paying double time for evening and night work, which seems to be the thing you have most trouble with? Your school is turning girls out fast enough, it appears, but you're not keeping them. Holding the girls is the solution of your problem; you are trying to solve it by getting more."

"We're trying to do both," said Mr. Sylvan.

"It is the law of the inevitable, not of best endeavor, that is confronting you. The situation is different with public utilities; unlike other businesses and industries they've got to get emploves, however it may be necessary.

"Your chief operators say they see daylight ahead; your engineers say they see daylight ahead. I shall adjourn this hearing until some later time, but in the interim I shall have the commission's engineer keep check upon you and see whether this promised improvement comes along."

Ohio

The commission approved the application of the Citizen's Telephone Company, of Deleware, for an increase of its rural telephone rates as follows:

Manual service for eight party residence stations from $1.25 to $1.50 a month; rural sub-exchange service on a resident party line from $1.25 to $1.50 a month.

The commission, however, would not approve a request for an increase of automatic rural main exchange rates.

The Newton Falls Telephone Company has been granted permission by the public utilities commission for raise in rates, effective January 1, 1920. This raise was asked for on account of marked increase in the cost of material and labor and in all other things in connection with the operation of the telephone exchange; in order that the increase in the number of subscribers is to be properly taken care of and adequate service given, it will be necessary to increase the capital stock of the company, and this cannot be done unless it can be shown that the stock is such as will pay a dividend. Because of this it has become necessary to increase the rates to subscribers.

The Sandusky Home Telephone Company and the Central Union Telephone Company filed joint application with the utilities commission, seeking authority to sell the Home Company plants in Sandusky, Castalia and Bloomingville to the Bell Company.

The Ohio State Telephone Company filed a new schedule of rates with the state public utilities commission affecting Cleveland, Akron, Zanesville, Barberton, Cuyahoga Falls, Chagrin Falls and Wickliffe.

Oklahoma

Further hearing by the corporation commission of the case of the Southwestern Bell Telephone Company, in which investigation of service and rates was being made for the purpose of revising rates, following release of the wires from Government control, was postponed until February 20. The commission was to have resumed the hearing December 17. An agreement was reached and temporary order made by extending rates until final action by the commission. The Burleson schedule was somewhat modified in the temporary order.

Minnesota

The Freeborn Telephone Exchange Company is permitted to establish and place in effect, as of February 1, 1920, the following schedule of rates at Freeborn, Minnesota:

Individual line business $1.50, extension stations business 50 cents, four-party line residence $1.25, extension stations residence 50 cents, rural multi-party (company owned) $1.25, rural switching charges $3.00 per annum.

The Fulda Telephone Company is permitted to place in effect at its several exchanges, as of February 1, 1920, the following sechedule of rates for local exchange service:

Brewster.

	per month
Individual line, business, gross	$2.50
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Dundee.

	per month
Individual line, business, gross	$2.50
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Fulda.

	per month
Individual line, business, gross	2.75
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Inter-Communicating sets, net	1.00
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Heron Lake.

	per month
Individual line, business, gross	2.75
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Inter-Communicating sets, net	1.00
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Reading.

	per month
Individual line, business, gross	$2.50
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Round Lake.

	per month
Individual line, business, gross	$2.50
Two-party line, business, gross	2.25
Business, extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Rushmore.

	per month
Individual line, business, gross	$2.50
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Storden.

	per month
Individual line, business, gross	$2.50
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50

Residence, extension, net	.50
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Westbrook.

	per month
Individual line, business, gross	$2.50
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Rural, multi-party, gross	1.50
Rural, switching, net	.35

Wilmont.

	per month
Individual line, business, gross	$2.50
Two-party line, business, gross	2.25
Business extension, net	.75
Individual line, residence, gross	1.50
Residence, extension, net	.50
Rural, multi-party, gross	1.50
Rural, switching, net	.35

All rates to be billed gross except where quoted net, all gross rates to be payable monthly in advance with a discount of 25 cents per month if paid on or before the 10th day of the month in which the service is rendered except connecting company rurals which are payable annually in advance and except that company rural rates are payable quarterly with a discount of 75 cents if paid on or before the 10th day of the first month, of the quarter; a discount of 50 cents if paid on or before the 10th day of the second month of the quarter, and a discount of 25 cents if paid on or before the 10th day of the 3rd month of the quarter.

The Fulda Telephone Company is authorized to establish divisions in which inter-communication between the subscribers of the company may be carried on without other charge than the regular monthly rental, as follows:

Fulda exchange, one division; Dundee and Heron Lake, one division; Westbrook and Storden, one division; Rushmore, Wilmont and Reading, one division; Brewster and Round Lake, one division.

The company is also authorized to place in effect the following schedule of toll rates computed on air line basis:

0 to 20 miles, 10 cents for 3 minutes; 20 to 25 miles, 15 cents for 3 minutes; 25 to 30 miles, 20 cents for 3 minues; 30 to 35 miles, 25 cents for 3 minutes. A charge of 5 cents for each additional minute.

Application for miscellaneous charges covering new installations, inside moves, transfers and temporary disconnects, is denied.

It is further ordered that the Fulda Telephone Company set up and keep a system of accounts in accordance with the uniform system of accounts for telephone companies prescribed by the commission.

The Long Prairie Telephone Company is permitted to place in effect, as of January 1, 1920, the following schedule of rates for local telephone service at Long Prairie, Minnesota:

Individual line, business, $2.75 gross; individual line, residence, $1.75 gross; two-party line, residence, $1.50, gross; rural multi-party (company owned) $1.25, net; business extension, 75 cents, net; residence extension, 50 cents, net; rural station switching (foreign) 35 cents, net.

A discount of 25 cents per month to be allowed from the above gross rates if the bill is paid on or before the 15th day of the month in which the service is rendered.

It is further ordered, that the Long Prairie Telephone Company set aside as a reserve for depreciation not more than six per cent per annum until otherwise ordered by the commission.

The Bertha Telephone Company is authorized to establish and place in effect as of February 1, 1920, the following schedule of rates at Bertha, Minnesota:

Individual line, business, $2.00; extension stations, 50 cents; individual line residence, $1.25; two-party line, residence, $1.00; extension station, residence, 50 cents; rural switching charges, 35 cents; extension bells, 15 cents.

It is ordered that the Bertha Telephone Company keep its accounts in accordance with the uniform system of accounting prescribed by the commission.

The Granite Falls Telephone Company is permitted to purchase from the Tri-State Telephone and Telegraph Company all of the local exchange property in the city of Granite Falls, Minnesota, with certain exceptions and reservations as provided for in the bill of sale which is a part of the application on file with the commission, but including the Tri-State Telephone and Telegraph Company's contracts with subscribers for service, rights of way for poles, wires or cables for local exchange purposes, and also its franchise or other permit to operate a local telephone exchange in the city.

The application of the Howard Lake Telephone Company to increase its local and rural telephone rates at Howard Lake, Minnesota, will be heard at the court room of the city hall in the City of Howard Lake, at 1 o'clock p. m. on February 9.

The application of the Sherburne County Rural Telephone Company to increase its local and rural telephone rates at Big Lake, Clear Lake, Becker and Zimmerman, Minnesota, will be heard at the Maccabee Hall in the Village of Big Lake, at 11 a. m. on February 10.

The application of the Edgerton Telephone Company to increase its local and rural telephone rates at Edgerton, Minnesota, will be heard at the village hall in the Village of Edgerton, at 12:30 p. m. on February 5, 1920.

The Watertown Telephone Company is permitted to establish and place in effect as of February 1, 1920, the following schedule of rates at Watertown, Delano, Maple Plain, Mount, St. Bonifacius, Mayer and Motordale, Minnesota:

Individual line business, except Delano, $2.25 per month gross.

Individual line business at Delano, $2.50 per month gross.

Two-party line business, except Delano, $1.75 per month gross.

Two-party line business at Delano, $2.00 per month gross.

Extension stations, business, 25 cents per month net.

Individual line residence, except Delano, $1.50 per month gross.

Individual line residence, at Delano, $1.75 per month gross.

Four-party line residence, $1.25 per month gross.

Extension stations, residence, 25 cents per month net.

Rural multi-party, $1.50 per month gross.

Rural schools and halls, $9.00 per year net.

Lodges and churches, $1.00 per month net.

Rural switching Delano exchange, with a minimum of $18 per circuit per annum, $4.20 per year net.

Extension bells, 10 cents per month net.

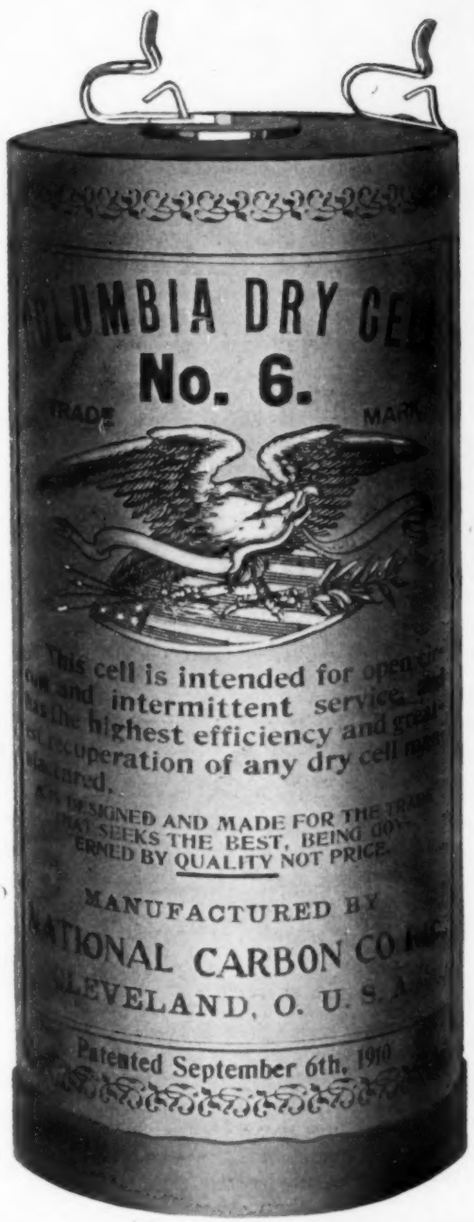
Individual line business or residence outside exchange area, one-party rate plus 25 cents additional for each quarter mile distance.

Temporary disconnection at one-half regular rate:

Summer season rates: One-party business, $20.00 gross; two-party business, $17.00 gross; one-party residence, $17.00 gross; four and

Columbia Telephone Cells

less cost per day of service



TELEPHONE MEN the world over know how the Columbia Gray Label proves the old adage that "talk is cheap." Columbias are built to make the line talk up with a snap; by reason of their long life they do it at less cost per talk—which means *less cost per day of service.* Fahnestock Spring Clip Binding Posts no extra charge.

NATIONAL CARBON COMPANY, Inc.
CLEVELAND OHIO

In Canada: Canadian National Carbon Co., Limited, Toronto

eight-party (W), $14.00 gross; residence and rural (D), $15.00 gross.

All local and rural rates, except at Delano, are payable quarterly with a discount of 75 cents if paid on or before the last day of the second month of the quarter in which the service is rendered.

At Delano, a discount of 25 cents per month to be allowed on local gross rates if paid on or before the 20th day of the month in which the service is rendered. Rural rates are payable quarterly with a discount of 75 cents if paid on or before the last day of the second month of the quarter in which the service is rendered.

A discount of $2.00 to be allowed on summer season rates if paid on or before July 31 of the season in which the service is rendered.

Making Designation Strips With a Camera

The most onerous task the equipment draftsmen of the Manhattan-Brony-Westchester division of the New York Telephone Company used to do was the drafting of special designation strips with white ink on black paper, for P. B. X. switchboards, says H. C. Coulter, in the *Telephone Review*.

For years, J. N. C. Graham, division equipment engineer, had been investigating various schemes of typewriting, printing and stamping these strips, but none of them "panned" out. One day he noticed one of his assistants with a new Kodak and a super abundance of the Kodak fan's enthusiasm. "Aha," thought he to himself, "here is a good chance to put him to work on a new scheme of making designation strips."

He called the assistant into his office, praised some of his Kodak work—with an eye to business—and said to him, "Now, suppose you see if you can rig up a scheme whereby you can take large figures, such as you might cut from a calendar, set them up against a wall and photograph them for designation strips."

It was a hot day, and the assistant mused inwardly on the strange effect of the heat, but outwardly he smiled and said, "That's a fine idea. I'll see what I can do with it." He enjoyed the joke in secret for a few days and then prepared to demonstrate the fallacy of the scheme. His first step was to put a roll of bromide paper in his Kodak, paste some black figures on a piece of tracing cloth, set a row of Tungsten lamps back of the cloth, focus the camera on the figures, and expose and develop the paper.

Then the joke was on him. The development revealed clear white figures surrounded by dead black. Samples were passed around and admired from various swivel chair viewpoints and finally word came back to "go to it" and develop the process on a practical scale.

To begin with—a large box about two feet wide and six feet long was obtained with sixteen 60-watt lamps mounted in the bottom. A sheet of tracing cloth was stretched across the top and a panel of plate glass laid over the cloth. The office force referred facetiously to the box as a coffin, but by that time the inventor was too busy to feel annoyed, and stuck to the job, making a wood box camera, a quantity of "type" consisting of pieces of glass with black figures and letters pasted on them, spacing frames and minor appliances.

The spacing frames are twenty inches wide and five feet long, being just four times longer than the designation strips to which they correspond. They are laid on the glass panel on top of the lamp box and the type is set in rectangular spaces formed by strings stretched both ways across the frames.

When a "set-up" is completed, the camera is loaded with a sheet of bromide paper and placed on a shelf directly over the lamp box. The lens cap is removed and the lamps are turned on for one minute. The paper is then developed, fixed and dried. The strips are cut apart and are ready for use.

The length of the longest strips made is fifteen inches. This required the use of a large developing tray, which resulted in a waste of developer. To avoid this waste a developing trough and drum were constructed. The paper is fastened by a clip to the drum, which is turned by a crank (mechanical device, not the operator) and revolves in the solution. One ounce of developer is used for each sheet of paper and is then discarded.

About 800 special strips per month are made for all classes of P. B. X. boards and interior system sets. The operator mixes the developing and fixing solutions and does all other incidental work from the receipt of each order to the disbursement of the finished strips. The time required per strip is about the same as for drafting, when only one strip of a kind is made, but when duplicate strips are required for multiple boards, the time is shortened.

No previous experience or technical skill is required to operate the outfit. Anybody in the office, from the newest messenger to the division plant superintendent, can make designation strips.

The photographed strips are more uniform and durable and present a better appearance than drafted strips.

Extensive Improvements for Knoxville

Extensive improvements are being planned by the People's Telephone and Telegraph Company, at Knoxville, Tenn. The capital stock of the company is to be increased from $120,000 to $200,000.

The first improvements to be made will be to replace the single wire systems with cable lines, thus protecting the wires from all outside influences. This work is to begin as soon as the new charter is secured and the additional stock sold.

The company, which operates what is popularly known as the "new telephone," expects to establish an automatic system, such as is now in use in several large cities, and a small system of which is now in use at Mascot.

A distinctive feature of the automatic system is that any trouble, such as a break in he line occurs, it is immediately and automatically reported to the central office. At Mascot, for instance, a telephone in one of the mines of the American Zinc Company of Tennessee will get out of order. It is often the case that a man has called and made the necessary repairs before anyone in the mine knew that it was out of order.

The telephone company official stated that it would probably be a year or more before work of installing an automatic system is started here. However, such action is being planned.

Western Union Employes Enjoy Increase

Thirty-two thousand employes of the Western Union Telegraph and Telephone Company received salary increases amounting to $5,000,000, January 1. Employes in service more than one year received a 15 per cent increase, and those who have been in the service more than six months, but less than a year received a 10 per cent increase. Only employes earning less than $250 a month are affected.